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**Wentorf et al.**

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(54) **ASYMMETRIC TIBIAL COMPONENTS FOR A KNEE PROSTHESIS**

(75) Inventors: **Mary S. S. Wentorf**, Warsaw, IN (US); **Calie B. Grey**, Winona Lake, IN (US); **Shaun R. Cronin**, Warsaw, IN (US); **Scott E. Dykema**, Warsaw, IN (US)

(73) Assignee: **ZIMMER, INC.**, Warsaw, IN (US)

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(51) **Int. Cl.**

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CPC ..... ***A61F 2/389*** (2013.01); *A61F 2/4684* (2013.01); *A61F 2002/30326* (2013.01); *A61F 2002/30387* (2013.01); *A61F 2002/30403* (2013.01); *A61F 2002/30604* (2013.01); *A61F 2002/30616* (2013.01); *A61F 2002/30878* (2013.01); *A61F 2002/30884* (2013.01); *A61F 2220/0025* (2013.01)

(58) **Field of Classification Search**

USPC ..... 623/20.14, 23.44, 20.31–20.34

See application file for complete search history.

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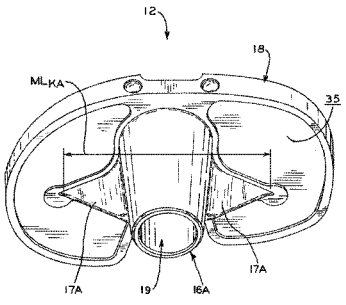
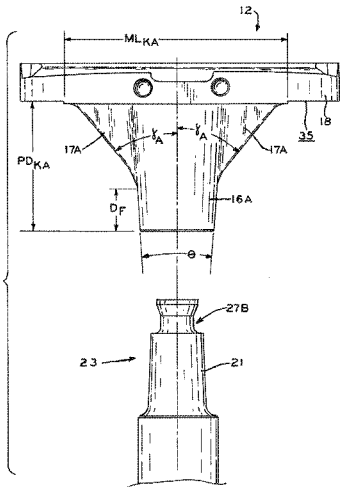
*Primary Examiner* — David H Willse
*Assistant Examiner* — Javier Blanco
(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(57) **ABSTRACT**

An orthopaedic tibial prosthesis includes a tibial baseplate with features designed for use with small-stature knee-replacement patients. The tibial prosthesis may include a shortened tibial keel, tibial keel fins which define a large angle with respect to a longitudinal axis of the keel, and/or tibial keel fins which extend along less than the entire longitudinal extent of the keel.

**26 Claims, 15 Drawing Sheets**



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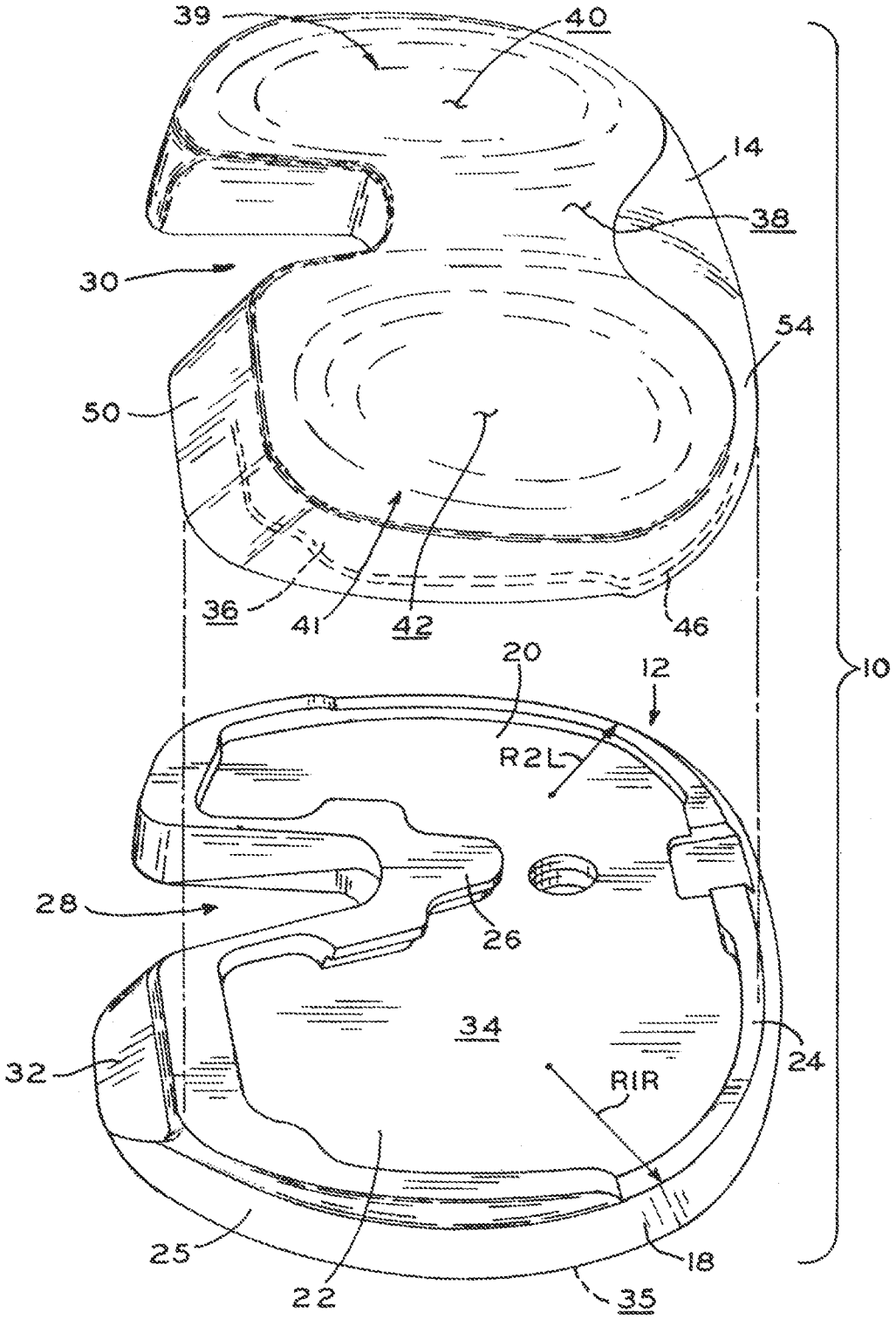
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FIG_1A

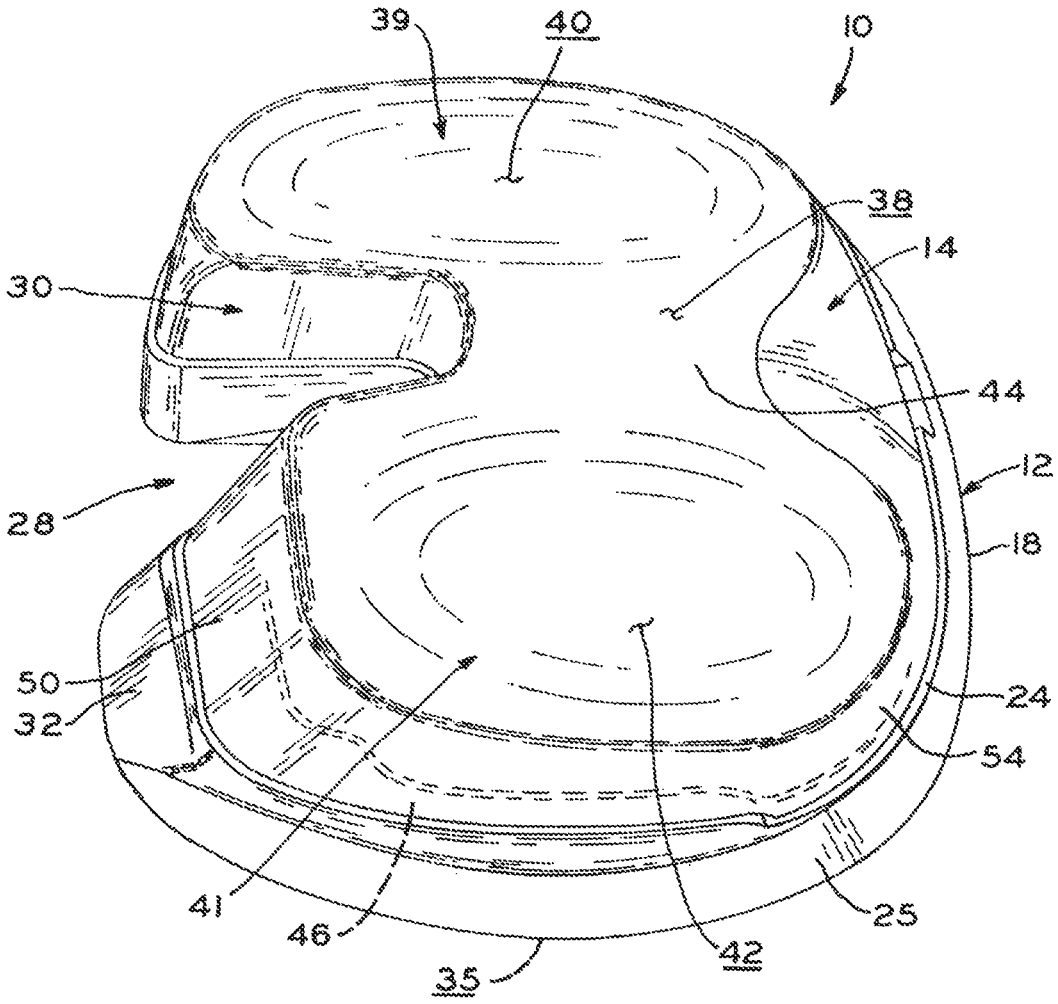
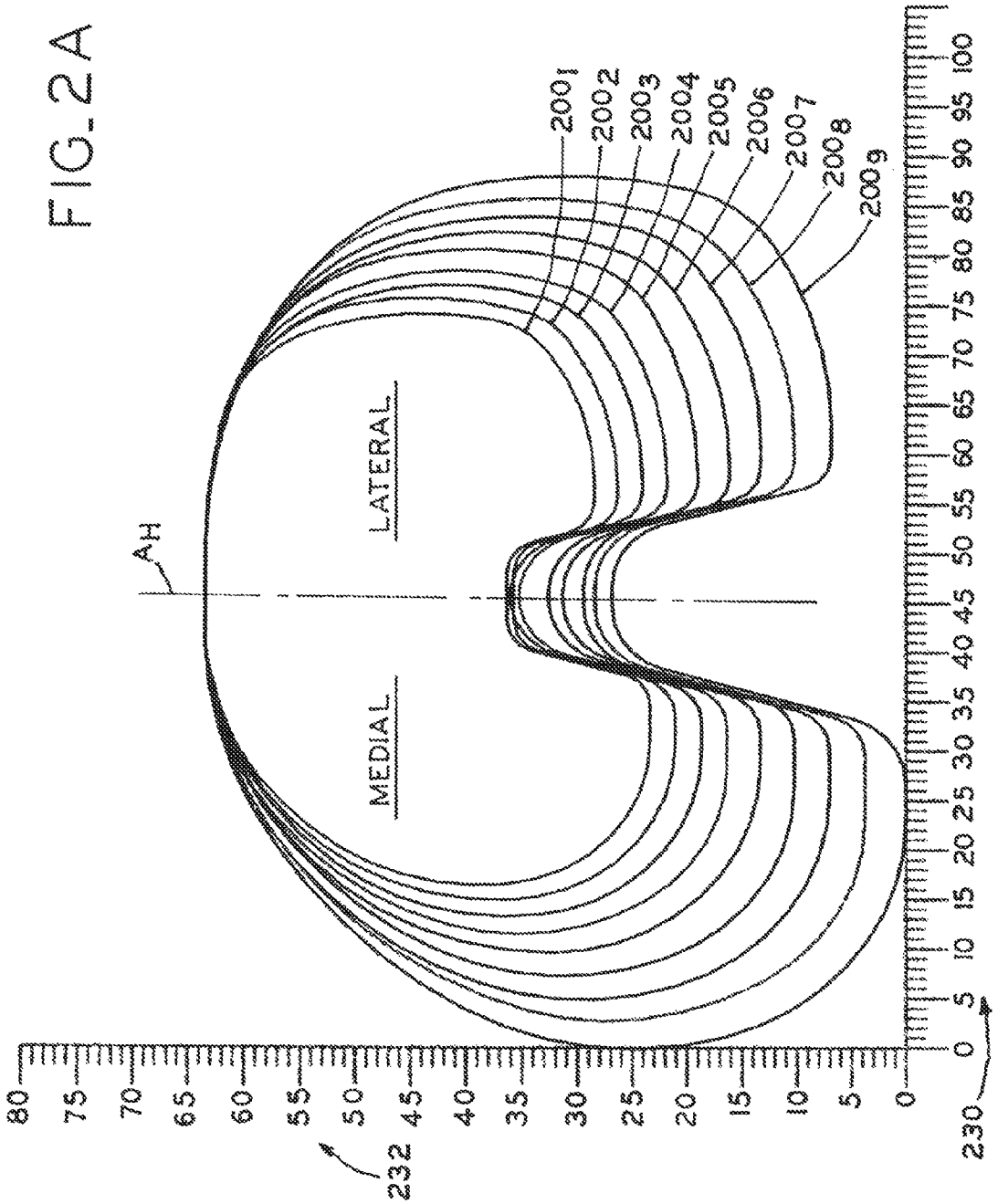



FIG_1B

FIG. 2A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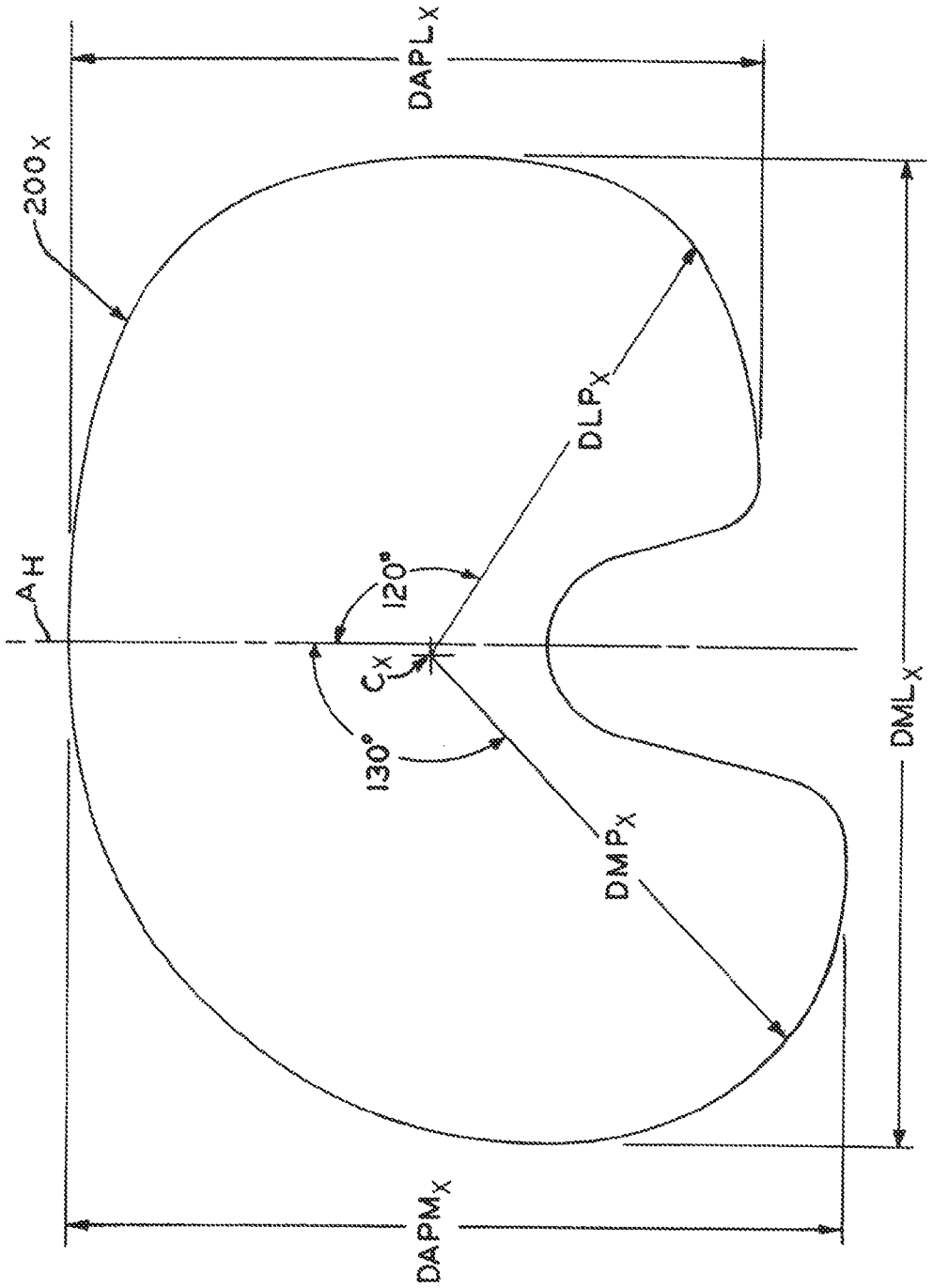
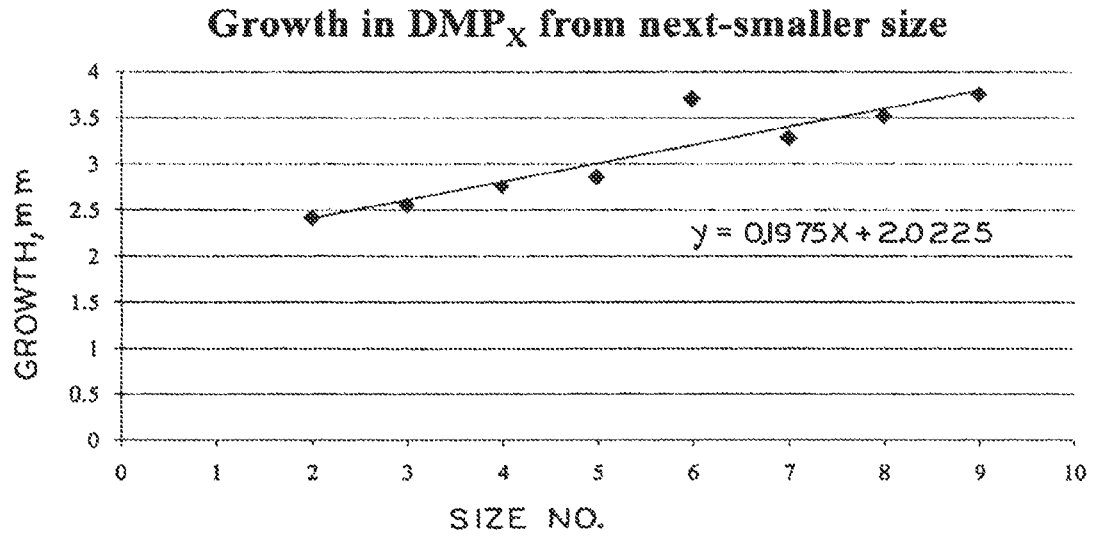



FIG. 2B


Growth in DMP$_X$ from next-smaller size
GROWTH, mm
SIZE NO.
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1
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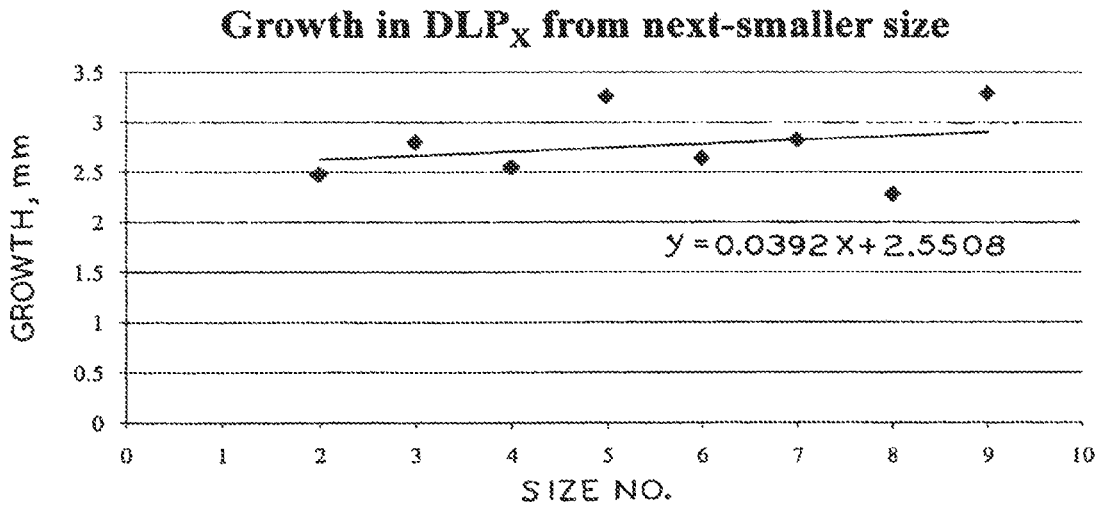
9
10

FIG. 2C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GROWTH, mm
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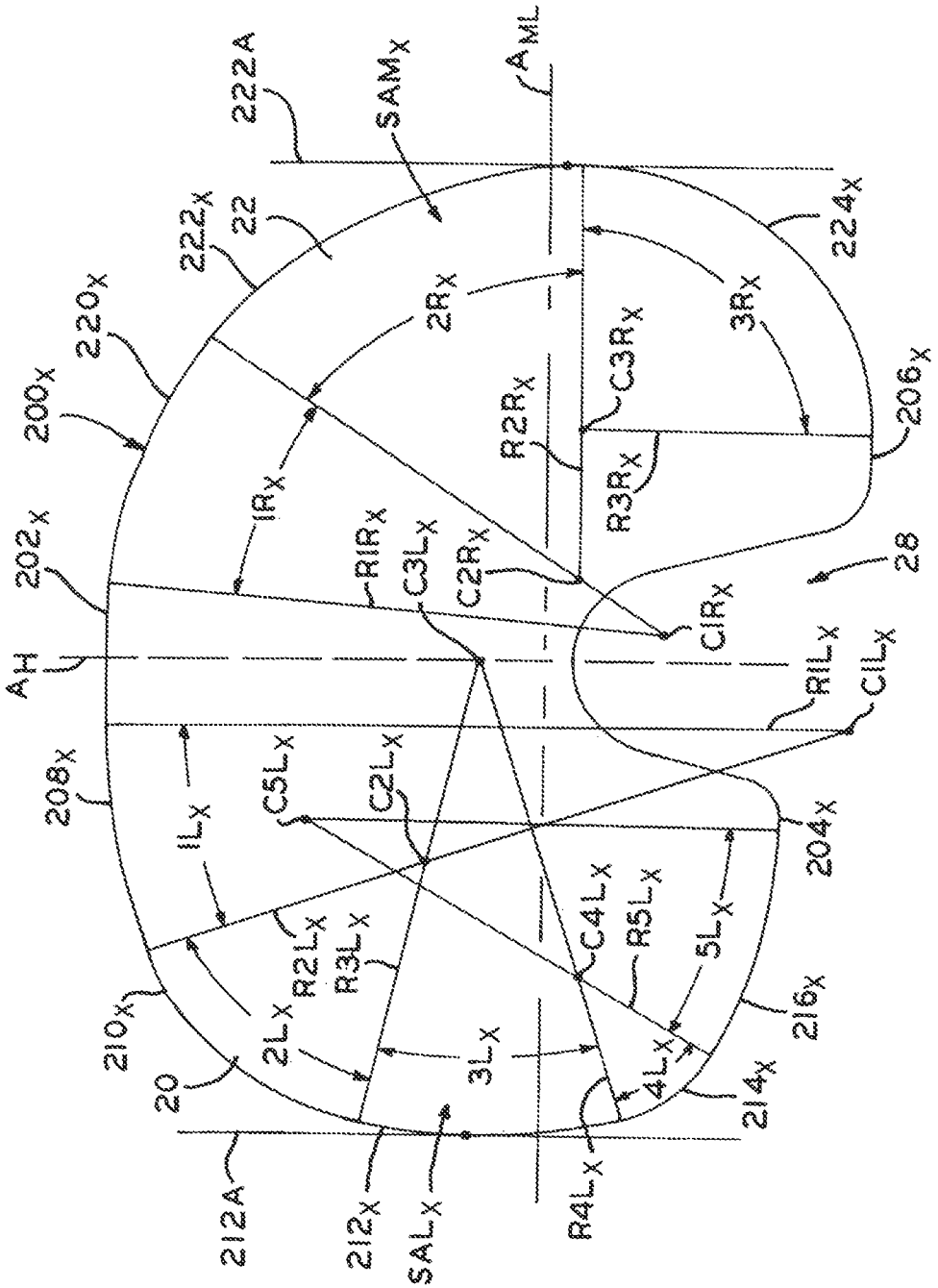
FIG. 2D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R4LX

FIG. 3A

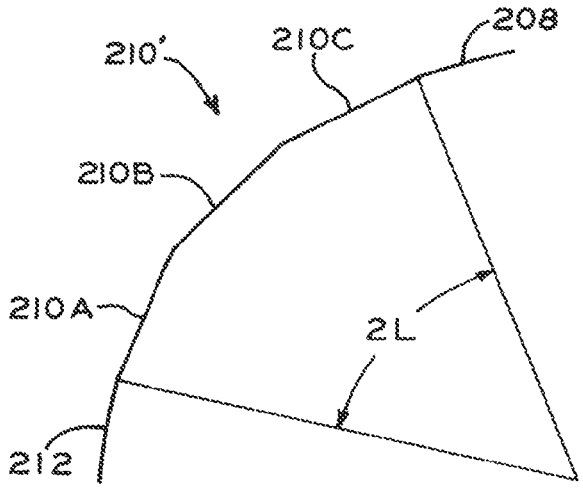



FIG_3B

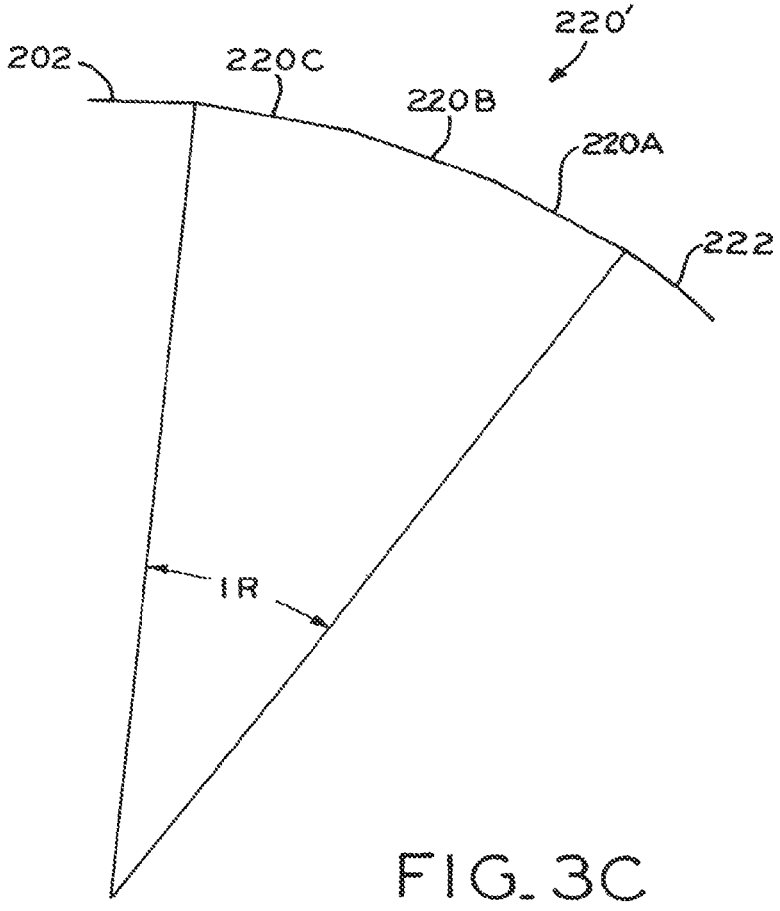
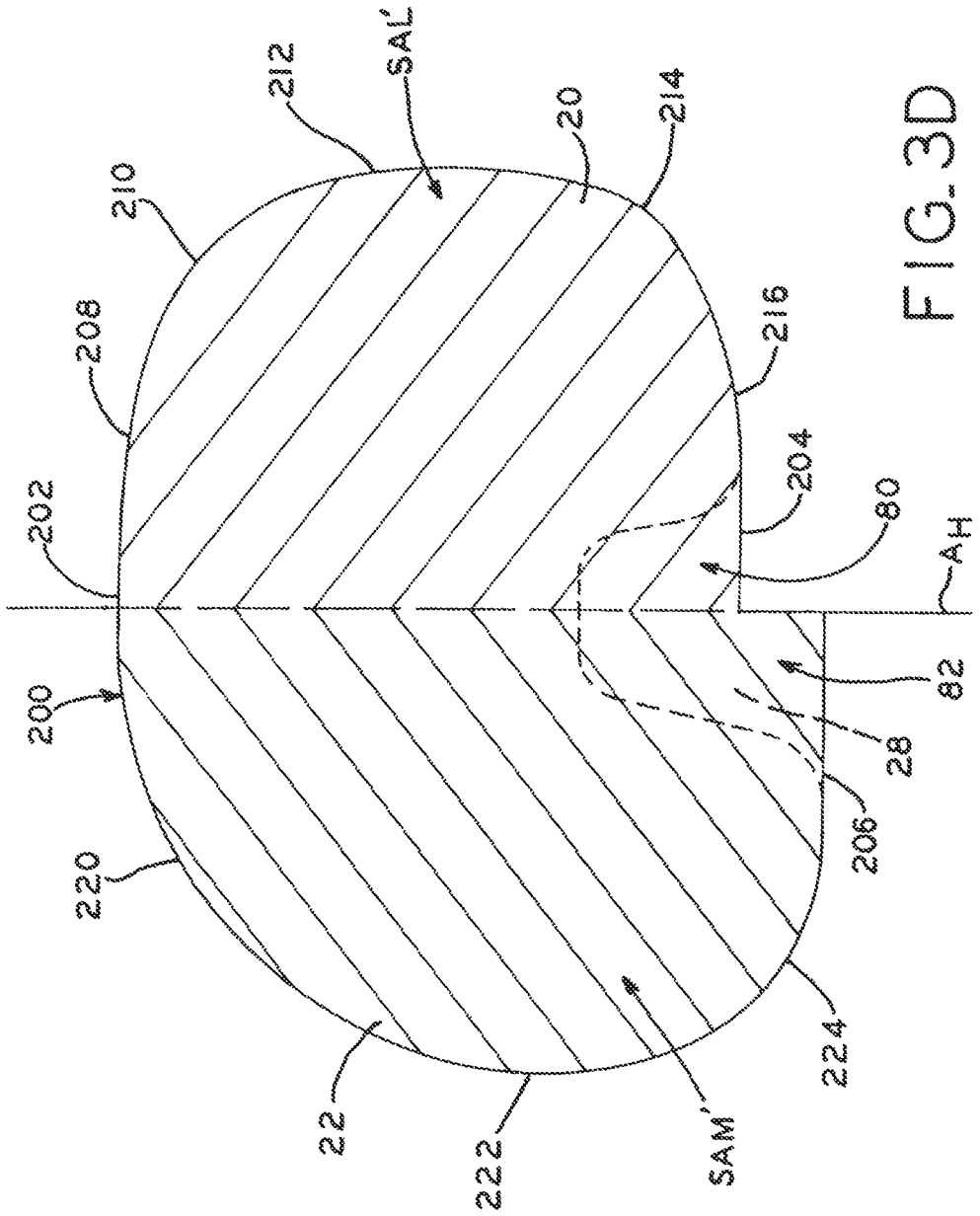



FIG_3C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SAM'

FIG. 3D

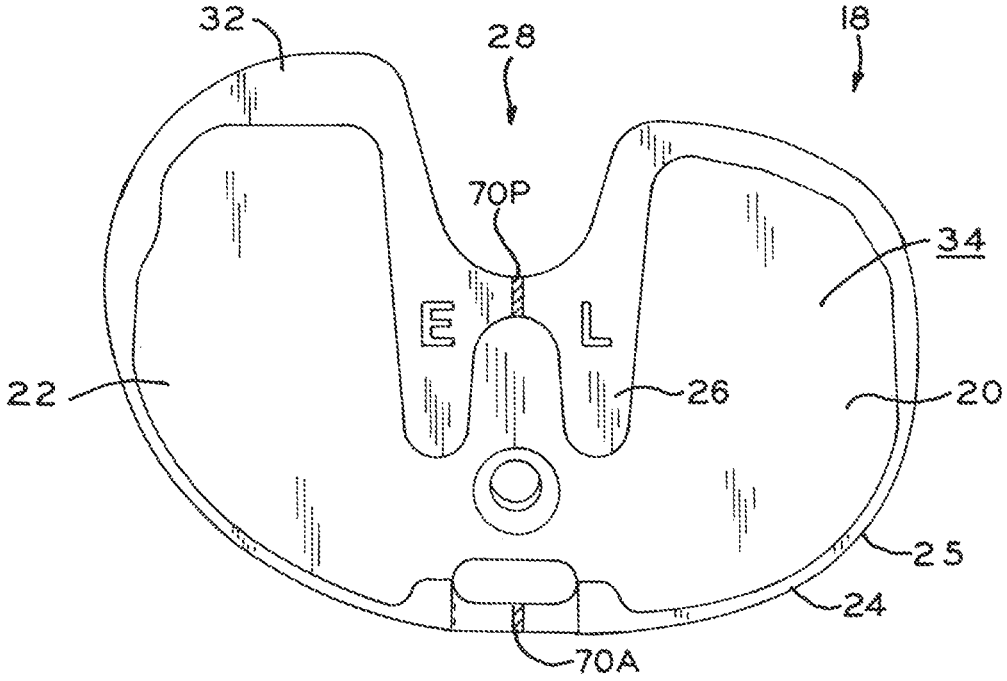
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FIG. 4A

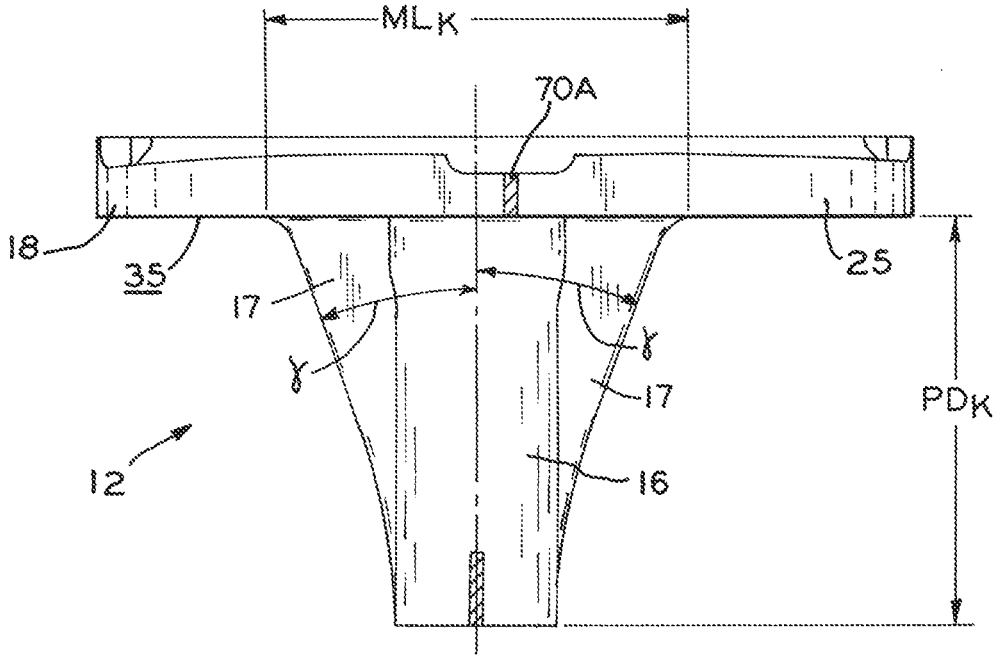
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FIG. 4B

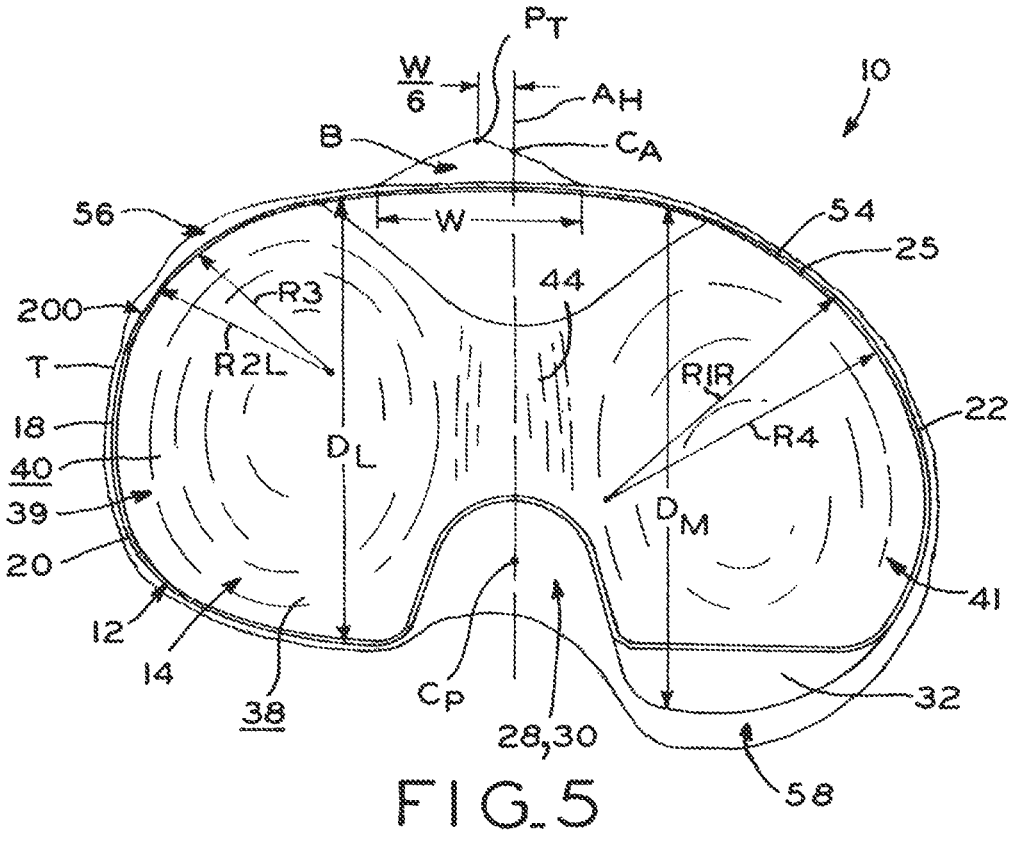
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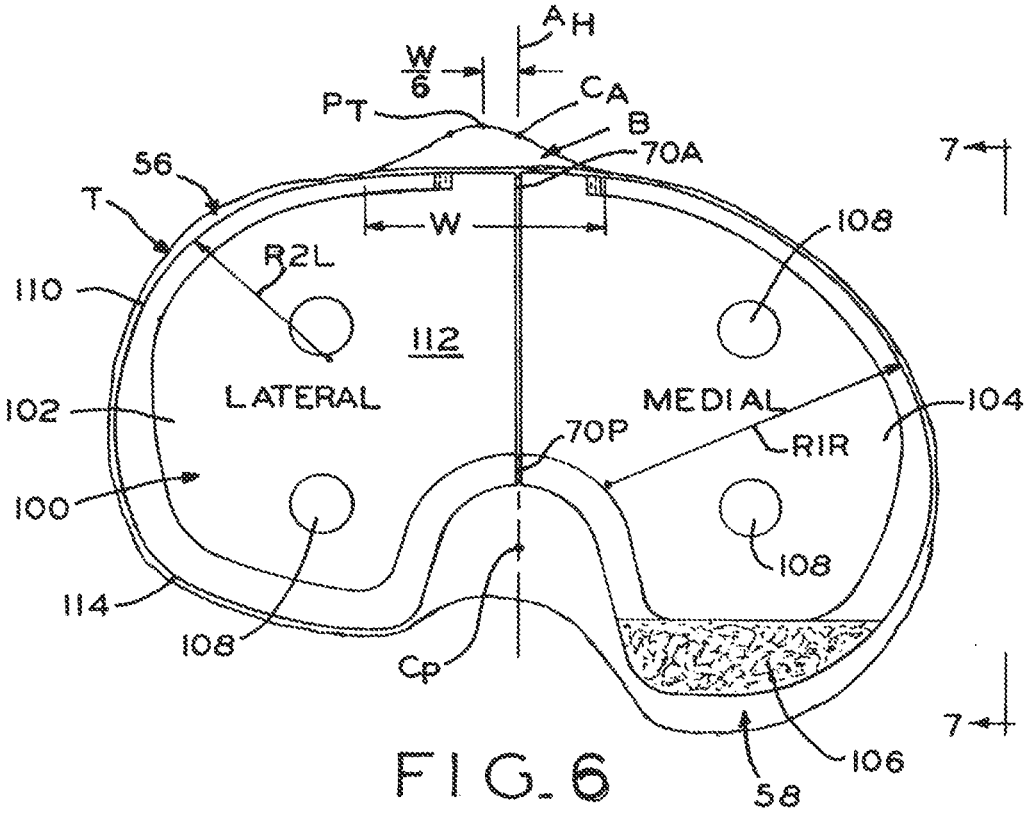
FIG. 5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RIR
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114
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Cp
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58

FIG. 6

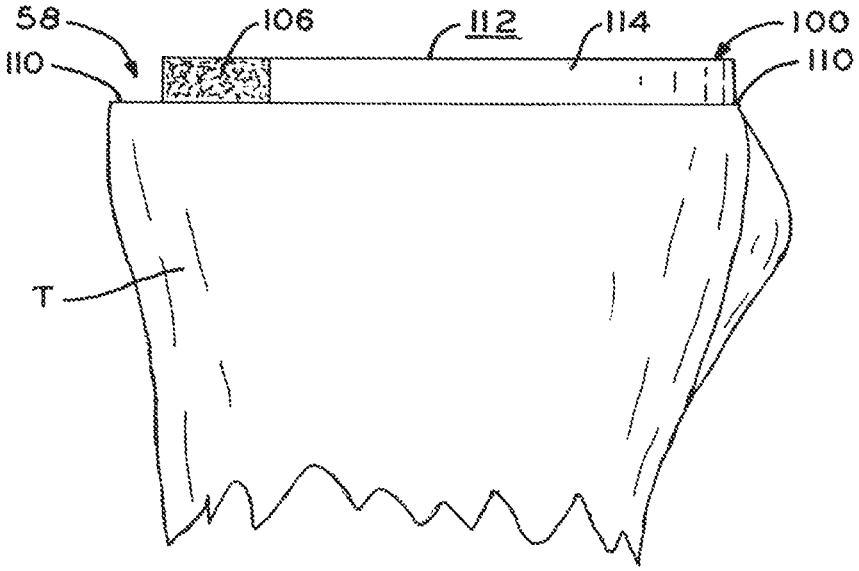
58
106
112
114
100
110
110
T

FIG. 7

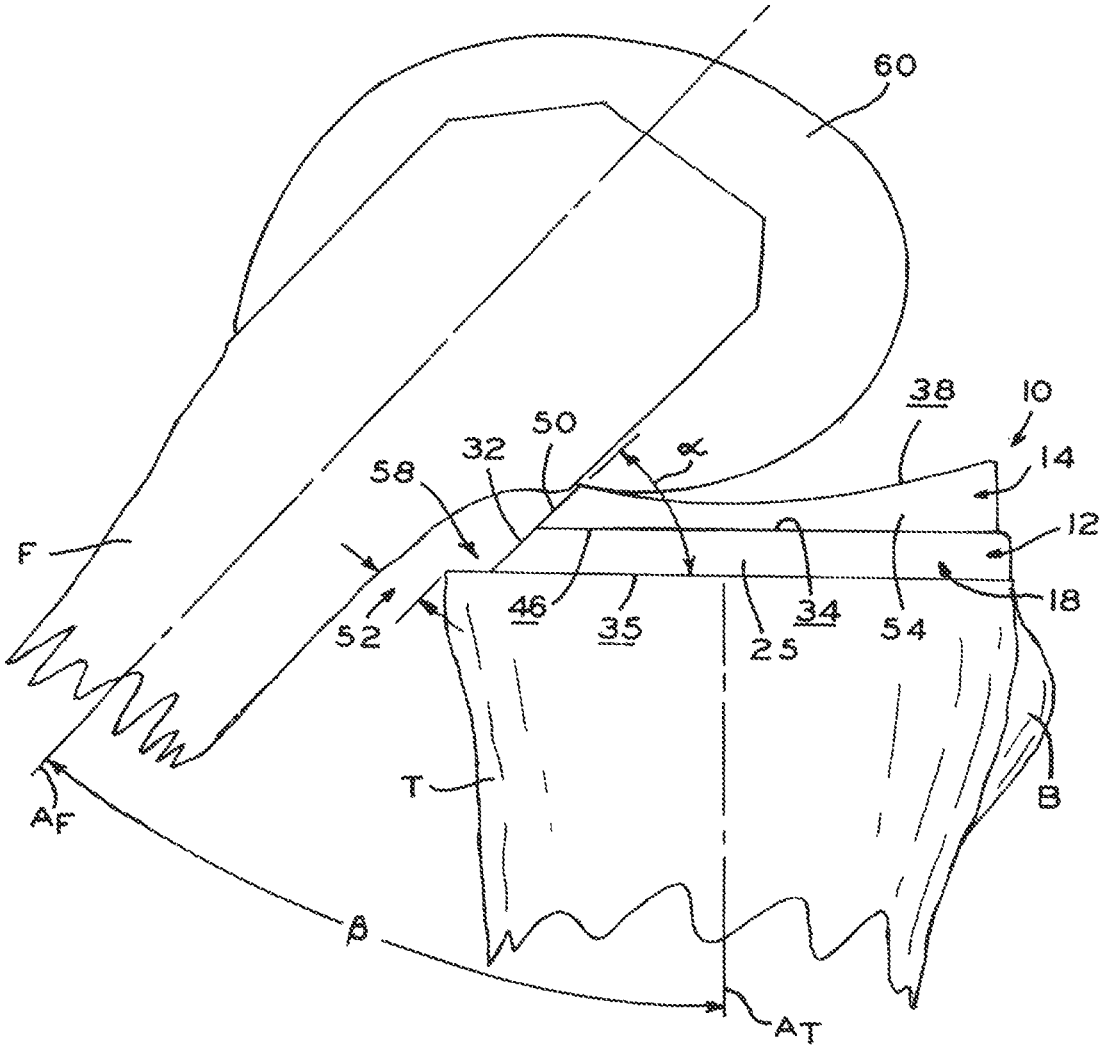


FIG. 8

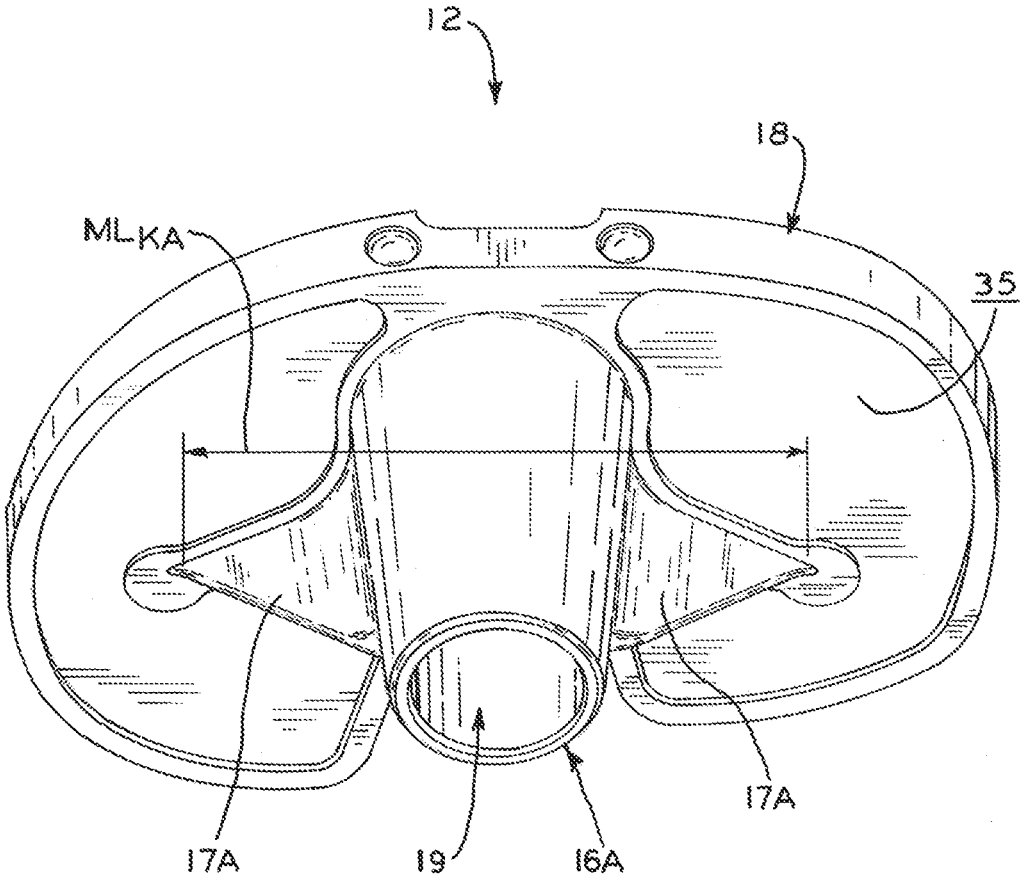


FIG. 9

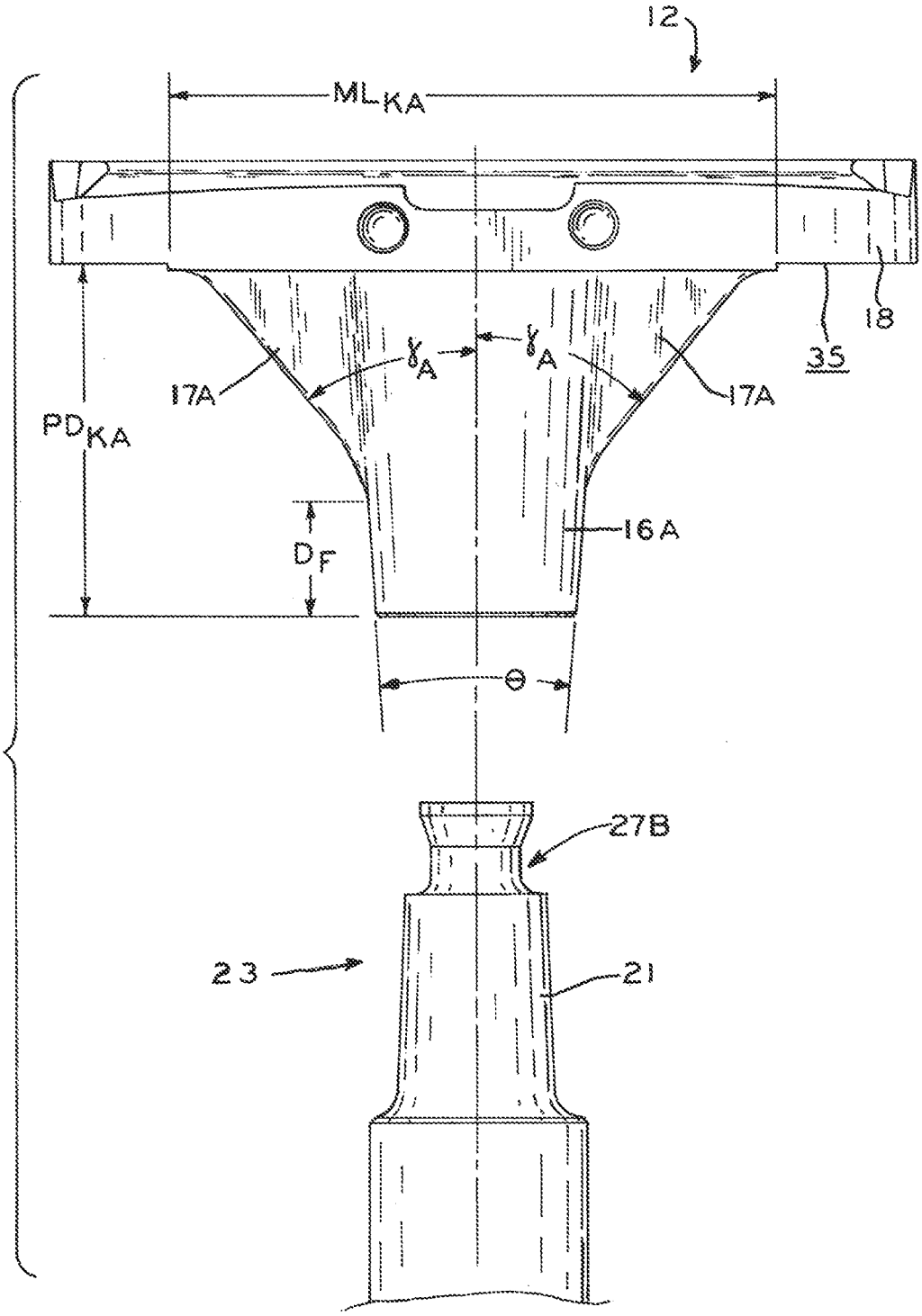


FIG_10

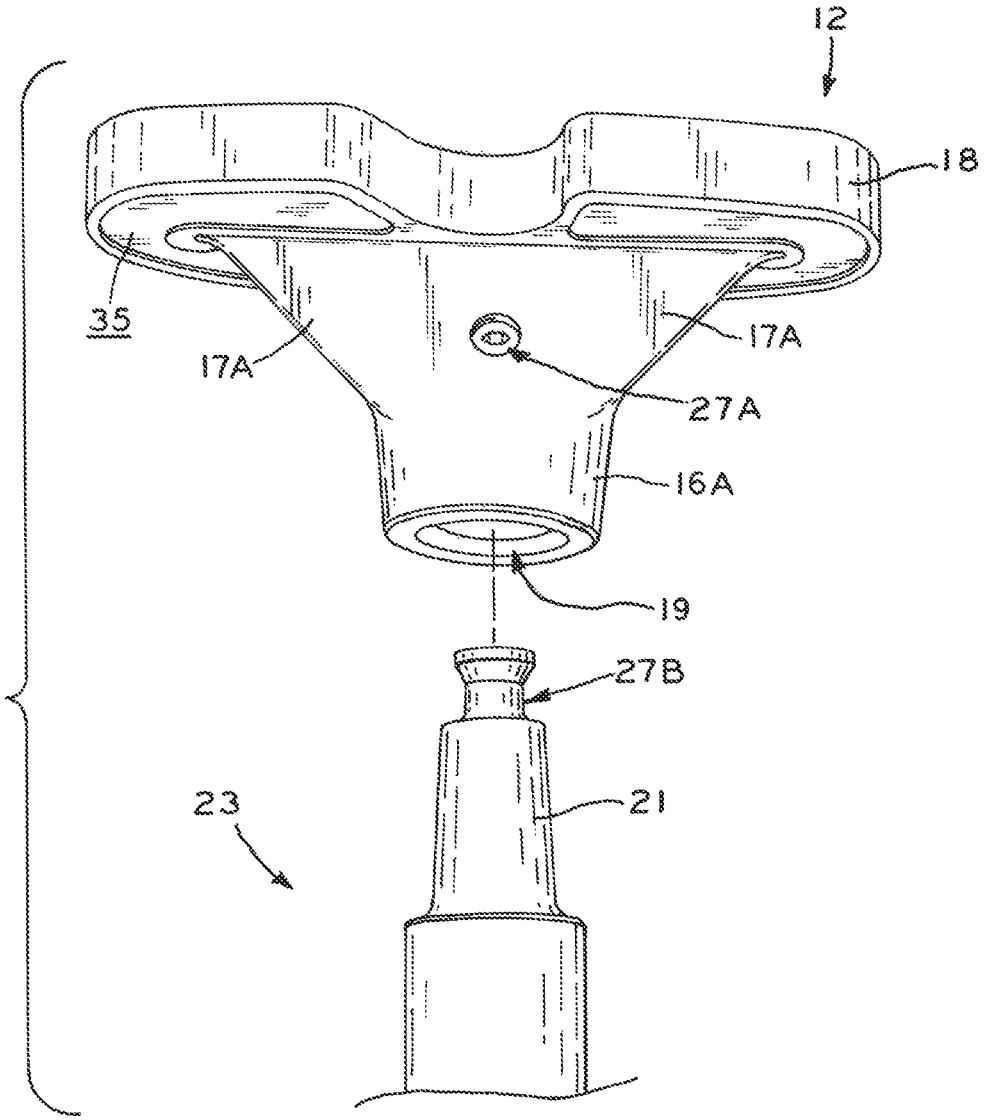


FIG_11

# ASYMMETRIC TIBIAL COMPONENTS FOR A KNEE PROSTHESIS

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit under Title 35, U.S.C. §119(e) of U.S. Provisional Patent Application Ser. No. 61/592,574 filed Jan. 30, 2012 and U.S. Provisional Patent Application Ser. No. 61/621,374 filed Apr. 6, 2012 both entitled "ASYMMETRIC TIBIAL COMPONENTS FOR A KNEE PROSTHESIS," the entire disclosures of which are hereby expressly incorporated herein by reference. This application is a Continuation-In-Part of U.S. patent application Ser. No. 13/189,336 filed Jul. 22, 2011, U.S. patent application Ser. No. 13/189,338 filed Jul. 22, 2011 and U.S. patent application Ser. No. 13/189,339 filed Jul. 22, 2011, each entitled "ASYMMETRIC TIBIAL COMPONENTS FOR A KNEE PROSTHESIS," all of which claim the benefit of U.S. Provisional Patent Application Ser. No. 61/381,800, filed Sep. 10, 2010, entitled "TIBIAL PROSTHESIS FACILITATING ROTATION ALIGNMENT," and of U.S. Provisional Patent Application Ser. No. 61/367,375, filed Jul. 24, 2010, entitled TIBIAL PROSTHESIS. The entire disclosures of all of the above-identified applications are hereby expressly incorporated by reference herein.

## BACKGROUND

1. Technical Field

The present disclosure relates to orthopaedic prostheses and, specifically, to tibial components in a knee prosthesis.

2. Description of the Related Art

Orthopaedic prostheses are commonly utilized to repair and/or replace damaged bone and tissue in the human body. For example, a knee prosthesis may include a tibial baseplate that is affixed to a resected or natural proximal tibia, a femoral component attached to a resected or natural distal femur, and a tibial bearing component coupled with the tibial baseplate and disposed between the tibial baseplate and femoral component. Knee prostheses frequently seek to provide articulation similar to a natural, anatomical articulation of a knee joint, including providing a wide range of flexion.

The tibial insert component, sometimes also referred to as a tibial bearing or meniscal component, is used to provide an appropriate level of friction and contact area at the interface between the femoral component and the tibial bearing component. For a knee prosthesis to provide a sufficient range of flexion with a desirable kinematic motion profile, the tibial bearing component and tibial baseplate must be sized and oriented to interact appropriately with the femoral component of the knee prosthesis throughout the flexion range. Substantial design efforts have been focused on providing a range of prosthesis component sizes and shapes to accommodate the natural variability in bone sizes and shapes in patients with orthopaedic prostheses, while preserving flexion range and desired kinematic motion profile.

In addition to facilitating implantation and providing enhanced kinematics through manipulation of the size and/or geometry of prosthesis components, protection and/or preservation of soft tissues in the natural knee joint is also desirable.

A given prosthetic component design (i.e., a tibial baseplate, tibial bearing component, or femoral component) may be provided to a surgeon as a kit including a variety of different sizes, so that the surgeon may choose an appropriate size intraoperatively and/or on the basis of pre-surgery planning.



An individual component may be selected from the kit based upon the surgeon's assessment of fit and kinematics, i.e., how closely the component matches the natural contours of a patient's bone and how smoothly the assembled knee joint prosthesis functions in conjunction with adjacent soft tissues and other anatomical structures. Soft tissue considerations include proper ligament tension and minimization of soft tissue impingement upon prosthetic surfaces, for example.

In addition to prosthetic sizing, the orientation of a prosthetic component on a resected or natural surface of a bone also impacts surgical outcomes. For example, the rotational orientation of a tibial baseplate and tibial bearing component with respect to a resected proximal tibia will affect the interaction between the corresponding femoral prosthesis and the tibial bearing component. The nature and amount of the coverage of a tibial baseplate over specific areas of the resected proximal tibia will also affect the fixation of the implant to the bone. Thus, substantial design efforts have been focused on providing prosthetic components which are appropriately sized for a variety of patient bone sizes and are adapted to be implanted in a particular, proper orientation to achieve desired prosthesis performance characteristics.

## SUMMARY

The present disclosure provides an orthopaedic tibial prosthesis which includes a tibial baseplate with features designed for use with small-stature knee-replacement patients. The tibial prosthesis may include a shortened tibial keel, tibial keel fins which define a large angle with respect to a longitudinal axis of the keel, and/or tibial keel fins which extend along less than the entire longitudinal extent of the keel.

The present disclosure also provides an orthopaedic tibial prosthesis including a tibial baseplate with an asymmetric periphery which promotes proper positioning and orientation on a resected tibia, while also facilitating enhanced kinematics, soft-tissue interaction, and long-term fixation of the complete knee prosthesis. The asymmetric baseplate periphery is sized and shaped to substantially match portions of the periphery of a typical resected proximal tibial surface, such that proper location and orientation is evident by resting the baseplate on the tibia. The baseplate periphery provides strategically positioned relief and/or clearance between the baseplate periphery and bone periphery, such as in the posterior-medial portion to prevent deep-flexion component impingement, and in the anterior-lateral portion to avoid undue interaction between the anatomic iliotibial band and prosthesis components.

In one form thereof, the present invention provides a small-stature tibial baseplate, comprising: a tibial plateau comprising: a distal surface sized and shaped to substantially cover a proximal resected surface of a tibia; a proximal surface opposite the distal surface, the proximal surface having a lateral compartment and a medial compartment opposite the lateral compartment; and a peripheral wall extending between the distal surface and the proximal surface; a tibial keel extending distally from the distal surface of the tibial plateau to define a longitudinal tibial keel axis; and at least one fin spanning a junction between the tibial keel and the distal surface, the at least one fin comprising a fin edge defining an angle of about 45 degrees with respect to the longitudinal tibial keel axis. In one aspect, the tibial keel defines a longitudinal extent equal to about 27 mm.

In another form thereof, the present invention provides a small-stature tibial baseplate, comprising: a tibial plateau comprising: a distal surface sized and shaped to substantially cover a proximal resected surface of a tibia; a proximal sur-

face opposite the distal surface, the proximal surface having a lateral compartment and a medial compartment opposite the lateral compartment; and a peripheral wall extending between the distal surface and the proximal surface; a tibial keel extending distally from a junction with the distal surface to an opposing distal tip, the tibial plateau defining a keel length between the junction and the distal tip equal to about 27 mm, the tibial keel monolithically formed with the tibial plateau and positioned thereupon so as to substantially coincide with an intramedullary canal of the tibia when the distal surface is placed upon the tibia, the tibial keel comprising a first diameter at the junction between the distal surface and the tibial keel and a second diameter at the distal tip of the tibial keel, the first diameter and the second diameter equal to at least 13 mm; and a medial fin and a lateral fin each spanning a portion of the junction between the tibial keel and the tibial plateau, the medial fin mating with the distal surface at the medial compartment, the lateral fin mating with the distal surface at the lateral compartment.

## BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. **1**A is an exploded, perspective view of a tibial baseplate and tibial bearing component in accordance with the present disclosure;

FIG. **1**B is an assembled, perspective view of the tibial baseplate and tibial bearing component shown in FIG. **1**A;

FIG. **2**A is a top plan view of the peripheries of a set of nine tibial baseplates made in accordance with the present disclosure, in which the peripheries are shown to scale according to the illustrated scales in millimeters in the bottom and right-hand margins of the page;

FIG. **2**B is a top plan view of the periphery of a tibial baseplate made in accordance with the present disclosure;

FIG. **2**C is a graph illustrating the asymmetric growth of the posterior-medial compartment for the tibial baseplates shown in FIG. **2**A;

FIG. **2**D is a graph illustrating the asymmetric growth of the posterior-lateral compartment for the tibial baseplates shown in FIG. **2**A;

FIG. **3**A is top plan view of a periphery of a tibial baseplate made in accordance with the present disclosure, illustrating various arcs defined by the periphery;

FIG. **3**B is a partial, top plan view of the periphery shown in FIG. **3**A, illustrating an alternative lateral corner periphery;

FIG. **3**C is a partial, top plan view of the periphery shown in FIG. **3**A, illustrating an alternative medial corner periphery;

FIG. **3**D is a top plan view of the periphery of a tibial baseplate made in accordance with the present disclosure, illustrating medial and lateral surface area calculations without a PCL cutout;

FIG. **4**A is a top plan view of a tibial baseplate made in accordance with the present disclosure;

FIG. **4**B is a side elevation view of the tibial baseplate shown in FIG. **4**A;

FIG. **5** is a top plan view of a resected proximal tibial surface with a prosthetic tibial baseplate component and tibial bearing component made in accordance with the present disclosure mounted thereon;

FIG. **6** is a top plan view of a resected proximal tibial surface with a properly sized tibial trial component thereon;

FIG. **7** is a side, elevation view of the tibia and trial component shown in FIG. **6**;

FIG. **8** is a side, elevation view of the tibial components shown in FIG. **1**A, in conjunction with a femoral component;

FIG. **9** is a bottom, perspective view of a small stature tibial baseplate made in accordance with the present disclosure;

FIG. **10** is a front coronal, elevation view of the small stature tibial baseplate shown in FIG. **9**, together with a tibial stem extension; and

FIG. **11** is a rear coronal, perspective view of another small stature tibial baseplate, shown with the tibial stem extension of FIG. **10**.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate exemplary embodiments of the invention, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

## DETAILED DESCRIPTION

The present disclosure provides an asymmetric knee joint prosthesis which facilitates proper rotational and spatial orientation of a tibial baseplate and tibial bearing component upon a resected proximal tibia, while also offering large-area contact with the resected proximal tibia. The prosthesis permits a wide range of flexion motion, protects natural soft tissue proximate the knee joint prosthesis, and optimizes long term fixation characteristics of the prosthesis.

In order to prepare the tibia and femur for receipt of a knee joint prosthesis of the present disclosure, any suitable methods or apparatuses may be used. As used herein, "proximal" refers to a direction generally toward the torso of a patient, and "distal" refers to the opposite direction of proximal, i.e., away from the torso of the patient.

As used herein, the "periphery" of a tibial prosthesis refers to any periphery as viewed in a top plan view, e.g., in a generally transverse anatomical plane. Alternatively, the periphery of a tibial prosthesis may be any periphery as viewed in bottom plan view, e.g., in a generally transverse plane and looking at the distal surface adapted to contact a resected proximal surface of a tibial bone.

As used herein, the term "centroid" or "geometric center" refers to the intersection of all straight lines that divide a given area into two parts of equal moment about each respective line. Stated another way, a geometric center may be said to be the "average" (i.e., arithmetic mean) of all points of the given area. Stated yet another way, the geometric center is a point in a two dimensional figure from which the sum of the displacement vectors of all points on the figure equals zero.

As used herein, a "disparity" or "difference" between two numerical values (e.g., one value "larger" or "smaller" than another), typically expressed as a percentage, is the difference between the two values divided by the smaller of the two values. For example, a smaller quantity having value **75** and a larger quantity having value **150** would have a percentage disparity of (150−75)/75, or 100%.

Referring to FIG. **5**, tibia T includes tibial tubercle B having mediolateral width W, with tubercle midpoint $P_T$ located on tubercle B approximately halfway across width W. While tubercle B is shown as having midpoint $P_T$ at the "peak" or point of maximum anterior eminence, it is recognized that midpoint $P_T$ of tibia T may be spaced from such a peak. Tibia T also includes attachment point $C_P$ representing the geometric center of the attachment area between the anatomic posterior cruciate ligament (PCL) and tibia T. Recognizing that

the PCL typically attaches to a tibia in two ligament "bundles," one of which is relatively anterior, lateral and proximal and the other of which relatively posterior, medial and distal, attachment point $C_P$ is contemplated as representing the anterior/lateral attachment area in an exemplary embodiment. However, it is contemplated that the posterior/medial attachment area, or the entire attachment area, could be used.

As used herein, "anterior" refers to a direction generally toward the front of a patient. "Posterior" refers to the opposite direction of anterior, i.e., toward the back of the patient.

In the context of patient anatomy, "home axis" $A_H$ refers to a generally anteroposterior axis extending from posterior point $C_P$ to an anterior point $C_A$, in which anterior point $C_A$ is disposed on tubercle B and medially spaced from tubercle midpoint $P_T$ by an amount equal to W/6. Stated another way, anterior point $C_A$ is laterally spaced by an amount equal to W/3 from the medial end of mediolateral width W, such that point $C_A$ lies on the "medial third" of the anterior tibial tubercle.

In the context of a prosthesis, such as tibial baseplate **12** described below, "home axis" $A_H$ refers to an axis oriented with respect to baseplate **12** such that the baseplate home axis $A_H$ of baseplate **12** is aligned with home axis $A_H$ of tibia T after implantation of baseplate **12** in a proper rotational and spatial orientation (as shown in FIG. **5**). In the illustrative embodiments shown in FIG. **3** and described in detail below, home axis $A_H$ bisects PCL cutout **28** at the posterior edge of periphery **200** of tibial plateau **18** (FIG. **5**), and bisects anterior edge **202** at the anterior edge of periphery **200** of tibial plateau **18**. It is contemplated that home axis $A_H$ may be oriented to other baseplate features, it being understood home axis $A_H$ of baseplate **12** is positioned such that that proper alignment and orientation of baseplate **12** upon tibia T positions the home axis $A_H$ of baseplate **12** coincident with home axis $A_H$ of tibia T.

Home axis $A_H$ of tibial baseplate **12** may be said to be an anteroposterior axis, as home axis $A_H$ extends generally anteriorly and posteriorly when baseplate **12** is implanted upon tibia T. Tibial baseplate also defines mediolateral axis $A_{ML}$, which lies along the longest line segment contained within periphery **200** that is also perpendicular to home axis $A_H$ of baseplate **12**. As described below, home axis $A_H$ and mediolateral axis $A_{ML}$ cooperate to define a coordinate system useful for quantifying certain baseplate features in accordance with the present disclosure.

The embodiments shown and described with regard to FIGS. **1**A, **1**B, **3**A, **4**A, **4**B, **5** and **6** illustrate a left knee and associated features of a right-knee prosthesis, while the embodiments shown and described in FIGS. **2**A, **2**B and **3**D illustrate the periphery of a right knee prosthesis. Right and left knee configurations are mirror images of one another about a sagittal plane. Thus, it will be appreciated that all aspects of the prosthesis described herein are equally applicable to a left- or right-knee configuration.

1. Asymmetry of the Tibial Prosthesis.

Referring now to FIGS. **1**A and **1**B, tibial prosthesis **10** includes tibial baseplate **12** and tibial bearing component **14**. Tibial baseplate **12** may include a stem or keel **16** (FIG. **4**B) extending distally from proximal tibial plateau **18**, or may utilize other fixation structures for securing baseplate **12** to tibia T, such as distally extending pegs. Portions of the outer periphery defined by tibial plateau **18** closely correspond in size and shape with a resected proximal surface of tibia T, as described in detail below.

Tibial bearing component **14** and tibial baseplate **12** have a particular asymmetry, with respect to home axis $A_H$ (shown in FIG. **2**A and described above), that is designed to maximize tibial coverage for a large proportion of knee-replacement candidates. This high level of coverage allows a surgeon to cover the largest possible area on the proximal resected surface of the tibia, which in turn offers maximum coverage of cortical bone. Advantageously, the maximized coverage of cortical bone facilitates superior support of tibial baseplate **12**. A firm, enduring fixation of tibial baseplate **12** to tibia T is facilitated by large-area contact between the cortical and cancellous bone of tibia T and distal surface **35** of tibial plateau **18** (FIG. **4**B), which may be coated with porous ingrowth material and/or bone cement.

In an analysis of a several human specimens, variations in size and geometry for a variety of anatomic tibial features were observed and characterized. Geometrical commonalities between anatomic features, or lack thereof, were noted. Mean tibial peripheral geometries were calculated based on statistical analysis and extrapolation of the collected anatomical data, in view of the observed geometrical commonalities organized around anatomic home axis $A_H$. These calculated mean geometries were categorized by tibial size.

A comparison between the asymmetric peripheries for the present family of prostheses and the calculated mean tibial geometries was conducted. Based on the results of this comparison, it has been found that substantial tibial coverage can be achieved for a large proportion of patients using tibial components having asymmetric peripheries in accordance with the present disclosure. Moreover, this coverage can be achieved with a relatively small number of sizes, even where particular portions of the prosthesis periphery is intentionally "pulled back" from the tibial periphery in order to confer other orthopaedic benefits. Further, the particular asymmetry of tibial baseplate **12** can be expected to offer such coverage without overhanging any portion of the resected surface.

Thus, periphery **200** including the particular asymmetric profile as described below confers the benefits of maximum coverage, facilitation of proper rotation (discussed below), and long-term fixation as described herein. Such asymmetry may be demonstrated in various ways, including: by a comparison of adjacent radii in the medial and lateral compartments of the asymmetric periphery; by a comparison of the edge length in anterior-medial and anterior lateral corners of the periphery, for a comparable lateral and medial angular sweep; and by a comparison of the location of radius centers for the anterior-medial and anterior-lateral corners with respect to a mediolateral axis. Various comparisons and quantifications are presented in detail below. Specific data and other geometric details of the peripheries for the various prosthesis sizes, from which the below-identified comparisons and quantifications are derived, may be obtained from the draw-to-scale peripheries shown in FIG. **2**A.

Advantageously, the asymmetry of tibial component **12** encourages proper rotational orientation of baseplate **12** upon implantation thereof onto tibia T. As described in detail below, the asymmetry of periphery **200** (FIG. **2**A) of tibial plateau **18** is designed to provide a close match in selected areas of the lateral and medial compartments as compared to the anatomic bone. As such, a surgeon can select the largest possible component from among a family of different component sizes, such that the component substantially covers the resected tibia T with minimal gaps between the tibial periphery and component periphery **200**, as well as little or no overhang over any portions of the tibial periphery. Because the high congruence between prosthesis periphery **200** and the tibial periphery produces only a minimal gap between the peripheries (as shown in FIG. **5**), tibial baseplate **12** cannot be rotated significantly without causing tibial plateau **18** to over-

hang beyond the periphery of the resected tibial surface. Thus, proper rotation of baseplate **12** can be ascertained by the visual acuity between prosthesis periphery **200** and the resected tibial surface.

The following examples and data are presented with respect to tibial baseplate **12**. However, as described in more detail below, tibial bearing component **14** defines perimeter wall **54** which follows peripheral wall **25** of baseplate **12** except where noted. Thus, it is appreciated that the conclusions, trends and design features gleaned from data relating to the asymmetric periphery of tibial baseplate **12** also applies to the asymmetric periphery of tibial bearing component **14**, except where stated otherwise.

Lateral compartment **20** and medial compartment **22** of tibial plateau **18** are dissimilar in size and shape, giving rise to the asymmetry thereof. This asymmetry is designed so that peripheral wall **25** traces the perimeter of the resected proximal surface of tibia T, such that tibial plateau **18** covers a large proportion of the resected proximal tibial surface as shown in FIG. **5**. To achieve this large tibial coverage, tibial plateau **18** closely matches the periphery of tibia T in most areas as noted above. Nevertheless, as shown in FIG. **5**, for example, a small gap between periphery **200** of tibial plateau **18** and tibia T is formed to allow some freedom of positioning and rotational orientation. The gap is designed to have a substantially continuous width in most areas, including the anterior edge, anterior-medial corner, medial edge, lateral edge and lateral-posterior corner (all described in detail below).

However, certain aspects of the asymmetric shape are designed to intentionally deviate from the calculated anatomical shape to confer particular features and advantages in the context of a complete, implanted knee prosthesis. Referring to FIG. **5**, for example, tibial baseplate **12** and tibial bearing component **14** have anterior-lateral "corners" (described in detail below) which are "pulled back" to create gap **56** between tibia T and prosthesis **10** in the anterior-lateral area of the resected surface of tibia T. Advantageously, gap **56** creates extra space for "soft-tissue friendly" edges of prosthesis **10**, thereby minimizing impingement of the iliotibial band. In an exemplary embodiment, gap **56** may range from 0.5 mm for a small-size prosthesis (such as size **1**/A described below), to 1 mm for a medium-sized prosthesis (such as size **5**/E described below), to 2 mm for a large-sized prosthesis (such as size **9**/J described below).

Similarly, the posterior edge of the medial compartment may be "pulled back" from the adjacent edge of tibia T to define gap **58**. Gap **58** allows extra space for adjacent soft tissues, particularly in deep flexion as described below. Gap **58** also allows prosthesis **10** to be rotated about a lateral pivot by a small amount, thereby offering a surgeon the freedom to displace medial compartment **22** posteriorly as required or desired for a particular patient. In an exemplary embodiment, gap **58** is about 4 mm.

As described in detail below, the asymmetrical periphery also provides a large overall area for proximal surface **34** of baseplate **12**, which creates sufficient space for large contact areas between tibial bearing component **14** and femoral component **60** (FIG. **8**).

a. Medial/Lateral Peripheral Curvatures

The particular asymmetric shape of tibial plateau **18** (and of tibial bearing component **14**, which defines a similar periphery as described below) gives rise to a generally "boxy" or angular periphery in lateral compartment **20**, and a "rounded" or soft periphery in medial compartment **22**.

Turning to FIG. **3**A, the periphery **200** of tibial plateau **18** surrounds lateral compartment **20** and medial compartment **22**, each of which define a plurality of lateral and medial arcs extending between anterior edge **202** and lateral and medial posterior edges **204**, **206** respectively. In the illustrative embodiment of FIG. **3**A, anterior edge **202**, lateral posterior edge **204** and medial posterior edge **206** are substantially planar and parallel for ease of reference. However, it is contemplated that edges **202**, **204**, **206** may take on other shapes and configurations within the scope of the present disclosure, such as angled or arcuate.

In the exemplary embodiment of FIG. **3**A, lateral compartment **20** includes five separate arcs including lateral anterior edge arc **208**, anterior-lateral corner arc **210**, lateral edge arc **212**, posterior-lateral corner arc **214**, and lateral posterior edge arc **216**. Each of lateral arcs **208**, **210**, **212**, **214** and **216** defines angular sweep **1**L, **2**L, **3**L, **4**L and **5**L, respectively, having radii R**1**L, R**2**L, R**3**L, R**4**L and R**5**L respectively. A radius of a particular angular sweep extends from the respective radius center (i.e., one of centers C**1**L, C**2**L, C**3**L, C**4**L and C**5**L) to periphery **200**. Radii R**1**L, R**2**L, R**3**L, R**4**L and R**5**L each remain unchanged throughout the extent of angular sweeps **1**L, **2**L, **3**L, **4**L and **5**L, respectively.

Similarly, medial compartment **22** includes three separate arcs including anterior-medial corner arc **220**, medial edge arc **222** and posterior-lateral corner arc **224**, defining angular sweeps **1**R, **2**R and **3**R, respectively having radii R**1**R, R**2**R and R**3**R respectively.

In FIG. **2**A, peripheries $\mathbf{200}_X$ are shown for each of nine progressively larger component sizes, with $\mathbf{200}_1$ being the periphery of the smallest size (size "**1**" or "A") and $\mathbf{200}_9$ being the periphery of the largest size (size "**9**" or "J"). For purposes of the present disclosure, several quantities and features of tibial baseplate **12** may be described with the subscript "X" appearing after the reference numeral corresponding to a component size as set for in the Tables, Figures and description below. The subscript "X" indicates that the reference numeral applies to all nine differently-sized embodiments described and shown herein.

In exemplary embodiments, medial and lateral radii may be any value within the following ranges: for medial radius $\mathbf{1}R_X$, between about 27 mm and about 47 mm; for medial radius $\mathbf{2}R_X$, between about 21 mm and about 49 mm; for medial radius $\mathbf{3}R_X$, between about 14 mm and about 31 mm; for lateral radius $\mathbf{1}L_X$, between about 46 mm and about 59 mm; for lateral radius $\mathbf{2}L_X$, between about 13 mm and about 27 mm; for lateral radius $\mathbf{3}L_X$ between about 27 mm and about 46 mm; for lateral radius $\mathbf{4}L_X$ between about 6 mm and about 14 mm; and for lateral radius $\mathbf{5}L_X$ between about 22 mm and about 35 mm.

In exemplary embodiments, medial and lateral angular extents or sweeps may be any value within the following ranges: for medial angle $\mathbf{1}R_X$, between about 13 degrees and about 71 degrees; for medial angle $\mathbf{2}R_X$, between about 23 degrees and about 67 degrees; for medial angle $\mathbf{3}R_X$, between about 23 degrees and about 90 degrees; for lateral angle $\mathbf{1}L_X$, between about 11 degrees and about 32 degrees; for lateral angle $\mathbf{2}L_X$, between about 42 degrees and about 63 degrees; for lateral angle $\mathbf{3}L_X$, between about 23 degrees and about 47 degrees; for lateral angle $\mathbf{4}L_X$, between about 36 degrees and about 46 degrees; and for lateral angle $\mathbf{5}L_X$, between about 28 degrees and about 67 degrees;

The unique asymmetry of periphery **200** defined by tibial plateau **18** can be quantified in multiple ways with respect to the curvatures of lateral and medial compartments **20** and **22** as defined by the arrangement and geometry of lateral arcs **208**, **210**, **212**, **214**, **216** and medial arcs **220**, **222**, **224**.

One measure of the asymmetry of periphery **200** is found in a simple comparison of radii R**2**L and RIR, which are the anterior "corner" radii of lateral and medial compartments **20**

and **22** respectively. Generally speaking, a corner of a baseplate periphery may be said to be that portion of the periphery where a transition from an anterior or posterior edge to a lateral or medial edge occurs. For example, in the illustrative embodiment of FIG. **3**A, the anterior-lateral corner is principally occupied by anterior-lateral corner arc **210**, which defines a substantially medial-lateral tangent at the anterior end of arc **210** and a substantially anteroposterior tangent at the lateral end of arc **210**. Similarly, the medial corner of periphery **200** is principally occupied by anterior-medial corner arc **220**, which defines a substantially medial-lateral tangent at the anterior end of arc **220** and a more anteroposterior tangent at the lateral end of arc **220**. For some purposes, the anterior-medial corner of periphery **200** may be said to include a portion of medial edge arc **222**, as described below.

A periphery corner may also be defined by a particular angular sweep with respect to an anteroposterior reference axis. Such reference axis may extend posteriorly from an anterior-most point of a tibial prosthesis (e.g., from the center of anterior edge **202** of periphery **200**) to divide the prosthesis into medial and lateral halves. In a symmetrical prosthesis, the anteroposterior reference axis is the axis of symmetry.

In the illustrative embodiment of FIG. **3**A, the anteroposterior reference axis may be home axis $A_H$, such that the anterior-medial corner of periphery **200** occupies some or all of the 90-degree clockwise angular sweep between home axis $A_H$ (at zero degrees, i.e., the beginning of the clockwise sweep) and mediolateral axis $A_{ML}$ (at 90 degrees, i.e., the end of the sweep). Similarly, the anterior-lateral corner of periphery **200** occupies some or all of the 90-degree counter-clockwise angular sweep between home axis $A_H$ and mediolateral axis $A_{ML}$.

For example, the anterior-medial and anterior-lateral corners may each occupy the central 45 degree angular sweep of their respective 90-degree angular sweeps as described above. Thus, the anterior-lateral corner of periphery **200** would begin at a position rotated 22.5 degrees counter-clockwise from home axis $A_H$ as described above, and would end at 67.5 degrees counter-clockwise from home axis $A_H$. Similarly, the anterior-medial corner would begin at a 22.5-degree clockwise rotation and end at a 67.5 degree clockwise rotation.

It is contemplated that the anterior-lateral and anterior-medial corners may occupy any angular sweep as required or desired for a particular design. For purposes of comparison between two corners in a given prosthesis periphery, however, a comparable angular sweep for the lateral and medial sides is envisioned, i.e., the extent and location of the compared angles may be "mirror images" of one another about an anteroposterior axis. For example, in a comparison of anterior-lateral and anterior-medial radii R**2**L, R**1**R, it is contemplated that such comparison is calculated across lateral and medial angular sweeps which each begin and end at similar angular end points with respect to the chosen reference axis (e.g., home axis $A_H$).

As best seen in FIGS. **3**A and **5**, one aspect of the asymmetric periphery of baseplate **12** arises from R**1**$R_X$ being substantially larger than R**2**$L_X$. Table 1, below, also includes a comparison of radii R**1**$R_X$ and R**2**$L_X$ across nine exemplary component sizes, demonstrating that difference **Δ-12**RL between radius R**1**$R_X$ and radius R**2**$L_X$ may be as little as 48%, 76% or 78%, and may be as much as 102%, 103% or 149%. It is contemplated that radius R**1**$R_X$ may be larger than radius R**2**$L_X$ by any percentage value within any range defined by the listed values.

TABLE 1

Comparisons of Values of Respective Medial and Lateral Anterior Corner Radii

| SIZE | Δ-12RL R1R vs. R2L |
|---|---|
| 1/A | 103.0% |
| 2/B | 149.2% |
| 3/C | 82.4% |
| 4/D | 74.6% |
| 5/E | 90.9% |
| 6/F | 78.6% |
| 7/G | 102.2% |
| 8/H | 86.5% |
| 9/J | 48.1% |
| AVG | 90.6% |

All Δ values are expressed as the difference between a given pair of radii, expressed as a percentage of the smaller of the two radii

Stated another way, the smaller R**2**$L_X$ makes a sharper turn, thereby imparting a relatively more "boxy" appearance to the anterior corner of lateral compartment **20**, while the relatively larger radius R**1**$R_X$ makes a more gradual turn that imparts a more "rounded" appearance to the anterior corner of medial compartment **22**. In the exemplary nine sizes illustrated in FIG. **2**A and shown in Table 1, an average disparity between the lateral and medial anterior corner radii R**2**$L_X$ and R**1**$R_X$ is greater than 90%. In some sizes of periphery $\mathbf{200}_X$, the anterior-medial "corner" making the more gradual turn may also includes medial edge arc **222**.

As described in detail below, this "rounded-medial/boxy-lateral" asymmetry of the anterior corners of tibial plateau facilitates and encourages proper rotational orientation and positioning of baseplate **12** upon tibia T upon implantation by allowing periphery **200** to closely match the periphery of a typical resected tibia T (FIG. **5**), while also maximizing the surface area of proximal surface **34** of tibial plateau to allow for use of a tibial bearing component **14** with a concomitantly large proximal surface area.

As noted above, the small-radius "corner" defined by angle **2**L may be considered to have a similar angular sweep as a large-radius "corner" defined by angles **1**R, **2**R (or a combination of portions thereof) for purposes of comparing the two radii. Given this comparable angular sweep, another measure of the asymmetry defined by the medial and lateral anterior corners is the arc length of the corners. More particularly, because medial radii R**1**$R_X$ and R**2**$R_X$ are larger than lateral radius R**2**$L_X$ (as described above), it follows that the medial corner has a larger arc length as compared to the lateral corner arc length for a given angular sweep.

Moreover, while the peripheries of lateral and medial compartments **20**, **22** are shown as being generally rounded and therefore defining respective radii, it is contemplated that an asymmetric periphery in accordance with the present disclosure need not define a radius per se, but rather could include one or more straight line segments which, on the whole, define asymmetric corner edge lengths in the medial and lateral compartments. Referring to FIG. **3**B, for example, it is contemplated that an alternative anterior lateral corner **210'** could be comprised of three line segments **210**A, **210**B, **210**C which cooperate to span angular extent **2**L. Similarly, an alternative anterior medial corner **220'** could be comprised of three line segments **220**A, **220**B, **220**C which cooperate to span angular extent **1**R. Any of the other arcs which define periphery **200** could be similarly configured as one or more line segments. In the variant illustrated by FIGS. **3**B and **3**C, the difference between corner radii would not be an appropriate measure of asymmetry because the straight line seg-

ments would not define radii. Asymmetry of the medial and lateral anterior corners would instead be quantified by comparison of the respective lengths of the medial and lateral corner edges across comparable medial and lateral angular extents.

Yet another way to quantify the asymmetry of the anterior corner arcs (i.e., anterior-lateral corner arc **210** and anterior-medial corner arc **220**) is to compare the distance of the lateral and medial radius centers C**2**L and C**1**R respectively, from anterior edge **202** and/or mediolateral axis $A_{ML}$ (FIG. **3**A). In the boxy anterior-lateral corner, center $C2L_X$ of radius $R2L_X$ is anterior of mediolateral axis $A_{ML}$ and relatively close to anterior edge **202**. For the rounded, anterior-medial corner, centers $C1R_X$ and $C2R_X$ of radii $R1R_X$ and $R2R_X$, respectively, are posterior of mediolateral axis $A_{ML}$ and relatively far from anterior edge **202**.

Another metric for quantifying the "boxy vs. rounded" asymmetry of periphery **200** is a comparison between ratios of adjacent radii. In the more boxy lateral compartment **20**, pairs of adjacent radii define large ratios because the large edge radii (i.e., of lateral anterior edge arc **208**, lateral edge arc **212** and lateral posterior edge arc **216**) are much larger than the adjacent corner radii (i.e., of anterior-lateral corner arc **210** and posterior-lateral corner arc **214**). On the other hand, in the more rounded medial compartment **22**, pairs of adjacent radii define small ratios (i.e., nearly 1:1) because the radii of the medial arcs (i.e., anterior-medial corner arc **220**, medial edge arc **222** and posterior-medial corner arc **224**) are of similar magnitude.

In the illustrated embodiment of FIG. **3**A, lateral edge arc **212** is considered an "edge" because arc **212** defines tangent **212**A which is substantially perpendicular to anterior edge **202**. Just as a "corner" may be considered to be the portion of periphery **200** which makes a transition from anterior or posterior to medial or lateral, an edge is that portion of periphery **200** which encompasses the anterior, posterior, medial or lateral terminus of periphery **200**.

Similarly, medial edge arc **222** defines tangent **222**A which is also substantially perpendicular to anterior edge **202**. The medial "edge" of periphery **200** may be part of the same arc that extends around the anterior-medial corner and/or the anterior-lateral corner, as the medial arcs are similar. Indeed, as noted herein, medial compartment **22** may have a single arc which extends from anterior edge **202** to medial posterior edge **206**.

Table 2 shows a comparison between adjacent-radii ratios for lateral and medial compartments **20** and **22**. For each adjacent pair of radii, the difference between the radii magnitudes are expressed as a percentage of the smaller radius of the pair, as noted above.

TABLE 2

| Comparisons of Values of Respective Pairs of Baseplate Peripheral Radii | | | | | | |
|---|---|---|---|---|---|---|
| SIZE | Δ-12R R1R vs. R2R | Δ-23R R2R vs. R3R | Δ-12L R1L vs. R2L | Δ-23L R2L vs. R3L | Δ-34L R3L vs. R4L | Δ-45L R4L vs. R5L |
| 1/A | 18.3% | 58.6% | 337.3% | 141.8% | 323.5% | 194.1% |
| 2/B | 49.0% | 62.0% | 254.1% | 96.7% | 361.5% | 315.4% |
| 3/C | 24.0% | 48.8% | 247.1% | 58.8% | 203.4% | 214.6% |
| 4/D | 44.2% | 34.4% | 207.0% | 59.2% | 213.9% | 244.4% |
| 5/E | 23.3% | 57.9% | 151.5% | 80.6% | 250.0% | 250.0% |
| 6/F | 46.5% | 37.6% | 122.6% | 42.9% | 222.6% | 260.2% |
| 7/G | 25.3% | 38.9% | 110.8% | 64.5% | 264.3% | 176.2% |
| 8/H | 73.6% | 21.3% | 109.0% | 80.9% | 198.1% | 142.6% |

TABLE 2-continued

| Comparisons of Values of Respective Pairs of Baseplate Peripheral Radii | | | | | | |
|---|---|---|---|---|---|---|
| SIZE | Δ-12R R1R vs. R2R | Δ-23R R2R vs. R3R | Δ-12L R1L vs. R2L | Δ-23L R2L vs. R3L | Δ-34L R3L vs. R4L | Δ-45L R4L vs. R5L |
| 9/J | 21.9% | 61.2% | 70.4% | 68.5% | 264.0% | 172.0% |
| AVG | 36.2% | 46.7% | 178.9% | 77.1% | 255.7% | 218.8% |

All Δ values are expressed as the difference between a given pair of radii, expressed as a percentage of the smaller of the two radii

As illustrated in Table 2, the "boxy" periphery of lateral compartment **20** gives rise to disparity values **Δ-12**L, **Δ-23**L, **Δ-34**L and **Δ-45**L that are at least 42%, 48% or 59%, and as great as 323%, 337% or 362%. It is contemplated that the disparity between a pair of adjacent radii in the boxy periphery of lateral compartment **20** may be any percentage value within any range defined by any of the listed values. It is also contemplated that the lateral disparity values may be substantially higher, as required or desired for a particular application.

Meanwhile, the "rounded" periphery of medial compartment **22** gives rise to disparity values **Δ-12**R and **Δ-23**R that are as small as 21%, 23% or 25%, and no greater than 61%, 62% or 74%. It is contemplated that the disparity between a pair of adjacent radii in the rounded periphery of medial compartment **22** may be any value within any range defined by any of the listed values. It is also contemplated that the medial disparity values may be less than 21%, and as little as zero %, as required or desired for a particular application.

Moreover, the boxy shape of lateral compartment **20** and rounded shape of medial compartment **22** is also demonstrated by the number of arcs used to define the portion of periphery **200** in lateral and medial compartments **20**, **22**. In lateral compartment **20**, five arcs (i.e., arcs **208**, **210**, **212**, **204**, **216**) are used to define the lateral periphery, which is indicative of anterior, lateral and posterior "sides" of a box joined by the relatively sharp transitions of corner arcs **210**, **214**. On the other hand, medial compartment **22** uses only three radii (i.e., **220**, **222**, **224**), leaving no clear definition of any box "sides" or other transitions. Indeed, it is contemplated that medial compartment **22** could join anterior edge **202** to medial posterior edge **206** by a single radius within the scope of the present disclosure.

b. Surface Area of Medial and Lateral Baseplate Compartments

Referring still to FIG. **3**A, yet another characterization of the asymmetry of periphery **200** arises from disparities in surface area for lateral and medial compartments **20**, **22**. For purposes of the present disclosure, surface area of lateral compartment SAL is that area contained within periphery **200**, and on the lateral side of home axis $A_H$. Similarly, the surface area of medial compartment **22** is that area contained within periphery **200**, and on the medial side of home axis $A_H$.

In an exemplary embodiment, lateral surface area $SAL_X$ may be as little as 844 $mm^2$ or may be as much as 1892 $mm^2$, or may be any area within the range defined by the foregoing values. In an exemplary embodiment, medial surface area $SAM_X$ may be as little as 899 $mm^2$ or may be as much as 2140 $mm^2$, or may be any area within the range defined by the foregoing values.

Surfaces areas SAL and SAM do not include any of the area occupied by PCL cutout **28**, as any such area is not within periphery **200**. However, the asymmetry of surface areas SAL and SAM arises primarily from the differences in the geometry and placement of arcs **208**, **210**, **212**, **214**, **216**, **220**, **222**,

224 rather than from any asymmetry of PCL cutout **28**. In the illustrative embodiments of FIG. **2**A, for example, PCL cutout $28_X$ is symmetrical with respect to home axis $A_H$, but extends further posteriorly in medial compartment **22**.

Thus, it is contemplated that the asymmetry of surfaces areas SAL, SAM are little changed by exclusion of the PCL cutout **28** from the area calculation. As illustrated in FIG. **3**D, PCL cutout **28** is effectively excluded from calculation by extrapolating the line formed by lateral posterior edge **204** and medial posterior edge **206** inwardly to intersect with home axis $A_H$. In lateral compartment **20**, such extrapolation cooperates with the lateral side of PCL cutout **28** to define lateral fill area **80**. In medial compartment **22**, such extrapolation cooperates with the medial side of PCL cutout **28** to define medial fill area **82**.

In the illustrative embodiment of FIG. **3**D, lateral surface area $SAL_X$' may be as little as 892 $mm^2$ or may be as much as 2066 $mm^2$, or may be any area within the range defined by the foregoing values. In an exemplary embodiment, medial surface area $SAM_X$' may be as little as 986 $mm^2$ or may be as much as 2404 $mm^2$, or may be any area within the range defined by the foregoing values.

Tables 3 and 4 below illustrate that medial surface area $SAM_X$ occupies a greater percentage of the total surface area contained within periphery $200_X$, regardless of whether PCL cutout **28** is included in the calculation. That is to say, medial fill area **82** is larger than lateral fill area **80** by approximately the same proportion as medial and lateral surfaces areas $SAM_X$, $SAL_X$. In the exemplary embodiments of FIG. **3**A, medial surface area $SAM_X$ occupies between 52% and 53% of the total surface area regardless, while lateral surface area $SAM_X$ occupies the remainder. If the PCL cutout is excluded from the calculation as shown in FIG. **3**D, medial surface area $SAM_X$' occupies between 52% and 54% of the total surface area, while lateral surface area $SAM_X$' occupies the remainder. With or without the PCL cutout included in the calculation, it is contemplated that medial surface areas $SAM_X$, $SAM_X$' may occupy as little as 51% of the total surface area, and as much as 60% of the total surface area.

TABLE 3

Medial vs. Lateral Tibial Baseplate Surface Areas for Baseplates with a PCL Cutout (FIGS. 2A and 3A) With PCL Notch

| Size | Medial Surface Area $SAM_X$ as % of Total Surface Area |
|---|---|
| 1/A | 52% |
| 2/B | 52% |
| 3/C | 52% |
| 4/D | 52% |
| 5/E | 52% |
| 6/F | 52% |
| 7/G | 53% |
| 8/H | 53% |
| 9/J | 53% |

TABLE 4

Medial vs. Lateral Tibial Baseplate Surface Areas for Baseplates without a PCL Cutout (FIG. 3D) Without PCL Notch

| Size | Medial Surface Area $SAM_X$' as % of Total Surface Area |
|---|---|
| 1/A | 53% |
| 2/B | 52% |

TABLE 4-continued

Medial vs. Lateral Tibial Baseplate Surface Areas for Baseplates without a PCL Cutout (FIG. 3D) Without PCL Notch

| Size | Medial Surface Area $SAM_X$' as % of Total Surface Area |
|---|---|
| 3/C | 53% |
| 4/D | 53% |
| 5/E | 53% |
| 6/F | 53% |
| 7/G | 53% |
| 8/H | 54% |
| 9/J | 54% |

c. Anteroposterior Extent of Medial and Lateral Compartments

Still another way to characterize and quantify the asymmetry of tibial periphery **200** is to compare the overall anteroposterior extent of lateral and medial compartments **20**, **22**.

Turning to FIG. **2**A (which is drawn to scale, according to scales **230** and **232**) and FIG. **2**B, lateral compartment **20** of tibial plateau **18** defines overall lateral anteroposterior extent $DAPL_X$, while medial compartment **22** of tibial plateau **18** defines overall medial anteroposterior extent $DAPM_X$, where X is an integer between 1 and 9 corresponding to a particular component size as shown in FIG. **2**A, as noted above. As illustrated in Table 5 below, lateral anteroposterior extent $DAPL_X$ is less than medial anteroposterior extent $DAPM_X$, for all component sizes.

This disparity in anteroposterior extent can be said to result from medial compartment **22** extending posteriorly further than lateral compartment **20**. In the illustrative embodiment of FIG. **2**B, lateral anteroposterior extent $DAPL_X$ extends from anterior edge **202** to lateral posterior edge **204**, while medial anteroposterior extent $DAPM_X$ extends from anterior edge **202** to medial posterior edge **206**. Thus, if one takes anterior edge **202** to be the anteroposterior "zero point," the additional anteroposterior extent defined by medial compartment **22** is due entirely to the further posterior position of medial posterior edge **206**.

As set forth in the right-hand column of Table 5, exemplary embodiments of tibial baseplate **12** may define medial anteroposterior extent $DAPM_X$ that is larger than lateral anteroposterior extent $DAPL_X$ by as little as 12.1%, 12.2% or 12.4%, and as much as 13.7%, 14.2% or 14.5%. It is contemplated that such disparity between medial and lateral anteroposterior extents $DAPM_X$, $DAPL_X$ may be any percentage within any range defined by the listed values of Table 5. Advantageously, the particular asymmetric arrangement of tibial baseplate **12** with respect to anteroposterior extent of lateral and medial compartments **20**, **22** facilitates substantially complete coverage of tibia T, without overhanging the edge of tibia T, in a wide variety of patients.

TABLE 5

Overall A/P and M/L Dimensions for Tibial Baseplates (FIGS. 2A and 2B)

| Size (X) | Growth in A/P Medial Dimension (DAPM), from next-smaller size, mm | Growth in A/P Lateral Dimension (DAPL), from next-smaller size, mm | Additional A/P Extent of DAPM vs. DAPL, % of DAPL |
|---|---|---|---|
| 1/A | — | — | 14.5% |
| 2/B | 2.3 | 2.13 | 14.2% |
| 3/C | 2.4 | 2.25 | 13.7% |

TABLE 5-continued

Overall A/P and M/L Dimensions for Tibial Baseplates (FIGS. 2A and 2B)

| Size (X) | Growth in A/P Medial Dimension (DAPM), from next-smaller size, mm | Growth in A/P Lateral Dimension (DAPL), from next-smaller size, mm | Additional A/P Extent of DAPM vs. DAPL, % of DAPL |
|---|---|---|---|
| 4/D | 2.3 | 2.27 | 13.1% |
| 5/E | 3 | 2.8 | 12.7% |
| 6/F | 3.1 | 2.85 | 12.4% |
| 7/G | 3.2 | 2.81 | 12.5% |
| 8/H | 3.3 | 3.11 | 12.2% |
| 9/J | 3.73 | 3.34 | 12.1% |

For example, in an exemplary family of prosthesis sizes, at least 60% and as much as 90% coverage of the resected proximal surface is provided by tibial plateau **18** of tibial baseplate **12** when rotation is limited to +/−5 degrees from home axis $A_H$. In a majority of all patients, such coverage is between 75-85%. Coverage of up to 100% may be achieved within the scope of the present disclosure, such as by fully extending the posterior-medial and anterior-lateral coverage of tibial plateau (which intentionally leave gaps between tibial plateau **18** and the periphery of tibia T as noted herein).

The additional posteromedial material of tibial plateau **18** includes chamfer **32**, described in detail below with respect to the assembly of tibial baseplate **12** to tibial bearing component **14**. Chamfer **32** is formed in peripheral wall **25**, such that chamfer **32** forms angle α (FIG. **8**) with the distal or bone-contacting surface **35** of tibial plateau **18**. In the illustrated embodiment, chamfer **32** defines a substantially linear sagittal cross-sectional profile, with angle α between about 35 degrees and about 55 degrees. In addition, it is contemplated that chamfer **32** may have an arcuate profile in a sagittal, coronal and/or transverse plane, and may include convex or concave curvature as required or desired for a particular application.

2. Progressive Peripheral Growth Between Implant Sizes

In addition to the asymmetry of each individual size/embodiment of tibial baseplate **12**, described in detail above, the present disclosure also provides asymmetry in the way periphery **200** grows from one size to the next. Advantageously, this asymmetric peripheral growth accommodates observed growth trends in tibias T of differently-sized patients, while also preserving the optimal fit and coverage provided by baseplate **12**, and offering the other advantages of designs in accordance with the present disclosure as described herein.

In symmetrical peripheral growth, a larger size of baseplate is a scaled-up version of a smaller size and vice-versa. In the present asymmetrical peripheral growth, by contrast, certain parameters of tibial baseplate **12** grow faster than others as the overall size of the baseplate gets larger (i.e., from smallest size **1**/A through largest size **9**/J). Thus, differently-sized components made in accordance with the present disclosure are not proportional to one another in all respects, in that a larger tibial prosthesis is not proportionally larger than a smaller tibial prosthesis in all aspects.

Referring now to FIG. **2**B, periphery $\mathbf{200}_X$ defines centroid $C_X$, which is medially biased with respect to home axis $A_H$ owing to medial surface area SAM being larger than lateral surface area SAL (as described in detail above). Posterior-medial distance $DMP_X$ extends from centroid $C_X$ toward the posterior-medial "corner" of periphery $\mathbf{200}_X$ (i.e., toward posterior-medial corner arc **224**, shown in FIG. **3**A and described above) at an angle of 130 counter-clockwise degrees from home axis $A_H$. Similarly, posterior-lateral distance $DLP_X$ extends from centroid $C_X$ toward the posterior-lateral "corner" of periphery $\mathbf{200}_X$ (i.e., toward posterior-lateral corner arc **214**, shown in FIG. **3**A and described above) at an angle of 120 clockwise degrees from home axis $A_H$. The posterior-lateral and posterior-medial corners are defined in a similar fashion as the anterior-lateral and anterior-medial corners, described in detail above. Moreover, while the asymmetric posterior-medial and posterior lateral growth among consecutive sizes is described below with respect to distances $DLP_X$, $DMP_X$, such growth occurs in the entire area occupied by the posterior-medial and posterior-lateral corners.

As illustrated in FIG. **2**A and shown in Table 6 below, lateral- and medial-posterior distances $DLP_X$, $DMP_X$ do not grow linearly as smallest size **1**/A progresses among consecutive sizes to eventually reach largest size **9**/J. Rather, lateral- and medial-posterior distances $DLP_X$, $DMP_X$ exhibit an increase in the magnitude of growth as the sizes progress consecutively from size **1**/A to size **9**/J. This non-linear, asymmetric growth is illustrated in the graphs of FIGS. **2**C and **2**D and in Table 6 below.

TABLE 6

Growth of the Posterior-Medial and Posterior-Lateral Corners of Baseplate Periphery (FIGS. 2A and 2B)

| Size (X) | Growth in medial-posterior distance $DMP_X$ from centroid ($C_X$), compared to next-smaller size, mm | Growth in lateral-posterior distance ($DLP_X$) from centroid ($C_X$), compared to next-smaller size, mm |
|---|---|---|
| 1 | — | — |
| 2 | 2.42 | 2.48 |
| 3 | 2.56 | 2.8 |
| 4 | 2.76 | 2.55 |
| 5 | 2.86 | 3.26 |
| 6 | 3.71 | 2.64 |
| 7 | 3.28 | 2.83 |
| 8 | 3.52 | 2.28 |
| 9 | 3.76 | 3.29 |

In FIG. **2**C, the amount of growth in $DMP_X$ is plotted against size no. X. As illustrated, the family of tibial baseplates **12** illustrated in FIG. **2**A exhibit a steadily increasing growth in $DMP_X$, with nearly 20% average increase in growth from one size to the next consecutive size (as represented by the slope of the linear trend line having equation y=0.1975x+2.0225).

In FIG. **2**D, the amount of growth in $DLP_X$ is plotted against size no. X, and illustrates a smaller, but still positive growth increase across baseplate sizes. More specifically, the family of tibial baseplates **12** illustrated in FIG. **2**A exhibit a nearly 4% average increase in growth from one size to the next consecutive size (as represented by the slope of the linear trend line having equation y=0.0392x+2.5508).

As used herein, a "family" of prostheses refers to a set or kit of prostheses sharing common geometrical and/or performance characteristics. For example, the family of nine tibial baseplates whose peripheries $\mathbf{200}_X$ are shown in FIG. **2**A share a common asymmetry as described herein, such that each tibial baseplate is adapted to provide substantial tibial coverage, facilitate proper implant rotation and avoid impingement with various soft tissues of the knee. Typically, a family of prostheses includes a plurality of differently-sized components, with consecutively larger/smaller components sized to accommodate a variety of differently-sized bones. In the exemplary embodiments of the present disclosure, a size "**1**" or "A" prosthesis is the smallest prosthesis of the family,

a size "9" or "J" prosthesis is the largest prosthesis of the family, and each of the intermediate sizes "2" or "B" through "8" or "H" are consecutively larger sizes.

Advantageously, in the family or kit of prosthesis peripheries shown in FIG. **2**A, each tibial baseplate **12** (FIG. **1**A) having periphery $\mathbf{200}_X$ provides a close match to a particular subset of patient tibias T having a unique size and shape. Particular features of periphery $\mathbf{200}_X$ have been designed with non-linear growth which is calculated to provide the closest possible fit for the largest number of particular natural geometries found in anatomic tibias T, as described in detail herein. This close fit allows for maximum coverage of the resected proximal tibial periphery $\mathbf{200}_X$, by accommodating the non-linear changes which may occur across anatomic tibial periphery sizes. Lateral- and medial-posterior distances $DLP_X$, $DMP_X$ are exemplary non-linear growth parameters found in a family of tibial baseplates **12**, and are reflective of non-linear growth in mediolateral extent $DML_X$ and anteroposterior extents $DAPM_X$ and $DAPL_X$ across the various sizes.

3. Tibial Baseplates for Small-Stature Patients

As noted above, tibial baseplate **12** may be provided in a variety of sizes each defining a unique periphery $\mathbf{200}_X$. Periphery $\mathbf{200}_X$ is described for an exemplary family of baseplate sizes in U.S. Patent Application Publication No. 2012/0022659, filed Jul. 22, 2011 and entitled ASYMMETRIC TIBIAL COMPONENTS FOR A KNEE PROSTHESIS, U.S. Patent Application Publication No. 2012/0022660, filed Jul. 22, 2011 and entitled ASYMMETRIC TIBIAL COMPONENTS FOR A KNEE PROSTHESIS and U.S. Patent Application Publication No. 2012/0022658, filed Jul. 22, 2011 and entitled ASYMMETRIC TIBIAL COMPONENTS FOR A KNEE PROSTHESIS, each of which claims the benefit under Title 35, U.S.C. §119(e) of U.S. Provisional Patent Application Ser. No. 61/381,800, filed on Sep. 10, 2010 and entitled TIBIAL PROSTHESIS FACILITATING ROTATIONAL ALIGNMENT, U.S. Provisional Patent Application Ser. No. 61/367,375, filed on Jul. 24, 2010 and entitled TIBIAL PROSTHESIS. The entire disclosures of the aforementioned applications are hereby expressly incorporated by reference herein.

As described in detail below, the smallest two sizes of tibial baseplate **12** include other unique features to accommodate the special needs of smaller stature patients. More particularly, these small sizes of tibial baseplate **12** are not scaled down versions of the larger sizes, but instead include unique geometries suited to the smaller bones for which they are designed. Further, because the small stature tibial baseplates **12** have less material overall, special geometries are employed to selectively strengthen tibial baseplate **12** in areas where such strengthening would not be required for larger baseplate sizes.

In an exemplary embodiment, tibial baseplate **12** is considered "small stature" for nominal sizes **1** and **2**. For example, nominal size **1** of tibial baseplate **12** may define a medial/lateral extent $DML_1$ of about 57 mm, a maximum anterior/posterior extent DARK of about 40 mm, and a surface area of about 1390 $mm^2$ within periphery $\mathbf{200}_1$. Nominal size **2** of tibial baseplate **12** may define a medial/lateral extent $DML_2$ of about 61 mm, a maximum anterior/posterior extent $DAPM_2$ of about 43 mm, and a surface area of about 1580 $mm^2$ within periphery $\mathbf{200}_2$.

One special feature of the small-stature sizes of tibial baseplate **12** is the shape of the outer surface of keel **16**A extending distally from proximal tibial plateau **18**. In larger size tibial baseplate **12**, such as baseplate **12** shown in FIG. **4**B, keel **16** defines a substantially cylindrical outer profile. By contrast, FIG. **10** illustrates that keel **16**A of the small-stature size of tibial baseplate **12** has a generally conical, tapered outer profile defining taper angle θ. In an exemplary embodiment, angle θ may be about 9°. This 9° taper may be formed, for example, by tapering keel **16**A from a circular outer diameter of about 17.1 mm at the proximal terminus of keel **16**A (i.e., at the junction between keel **16**A and distal surface **35** of tibial plateau **18**) to a circular diameter of approximately 13.4 mm at the distal terminus of keel **16**A. Keel **16**, on the other hand, maintains a diameter between about 14 mm and about 16 mm that remains constant across the longitudinal extent. Moreover, prior art tibial baseplates include constant-diameter keels in this diameter range, such as the Zimmer NexGen Stemmed Tibial Plates and Natural Knee II Modular Cemented Tibial Plates. The NexGen Stemmed Tibial Plates and Natural Knee II Modular Cemented Tibial Plates are shown at pages 14 and 28, respectively, of the "Zimmer® Tibial Baseplate, Pocket Guide United States Version," the entire disclosure of which is hereby expressly incorporated herein by reference, a copy of which is submitted on even date herewith in an Information Disclosure Statement.

In an exemplary embodiment, keels **16**, **16**A are monolithically or integrally formed with tibial plateau **18**, though it is contemplated that keels **16**, **16**A may be separately attachable to tibial plateau **18**. Further, in an exemplary embodiment keels **16**, **16**A themselves are monolithically formed as a single piece, rather than being assembled from multiple partial pieces to form a complete keel.

Referring to FIGS. **9** and **10**, another unique feature of small-stature sizes of tibial baseplate **12** is the geometry and arrangement of keel fins **17**A as compared to keel fins **17** (FIG. **4**B) of larger-stature sizes of baseplate **12**. More particularly, fins **17**A extend along less than the entire longitudinal extent of keel **16**A, as best shown in FIG. **10**, such that fins **17**A terminate into the conical outer surface of keel **16**A at a distance $D_F$ above the distal tip of keel **16**A. In an exemplary embodiment, distance $D_F$ is about 7 mm, or about 26% of overall longitudinal extent $PD_{KA}$ of keel **16**A, such that fins **17**A extend along the remaining 74% of longitudinal extent $PD_{KA}$.

Keel fins **17**A of small-stature sizes of tibial baseplate **12** also define keel fin angle $\gamma_A$ (FIG. **10**) with respect to the longitudinal axis of keel **16**A, which is larger than keel fin angle γ (FIG. **4**B) defined by fins **17** of larger size tibial baseplate **12**. In an exemplary embodiment, keel fin angle $\gamma_A$ is equal to about 45°, as compared to keel fin angle γ of about 22-27° defined by larger sizes of baseplate **12** and by prior art devices including the Zimmer NexGen MIS Stemmed baseplates shown at pages 4-5 of the "Zimmer® Tibial Baseplate, Pocket Guide United States Version," the entire disclosure of which is hereby expressly incorporated herein by reference, a copy of which is submitted on even date herewith in an Information Disclosure Statement. The increased magnitude of keel fin angle $\gamma_A$ concomitantly increases the overall medial/lateral extent in $ML_{KA}$ of keel fins **17**A at the junction with tibial plateau **18** at distal surface **35** for a given proximal/distal extent of keel fins **17**A. As illustrated in FIGS. **9** and **10**, medial/lateral extent in $ML_{KA}$ is the maximum medial/lateral distance defined by the medial and lateral fins **17**A at the junction thereof with tibial plateau **18**. In the illustrated embodiment, medial and lateral fins **17**A are the only fins provided as part of small-stature tibial baseplate **12**.

Provided that fins **17**A extend along a substantial portion of the longitudinal extent $PD_{KA}$ of keel **16**A (e.g., across 74% of longitudinal extent $PD_{KA}$, as noted above), medial/lateral keel extent $ML_{KA}$ may be equal to about 40 mm, which is commensurate with the corresponding medial/lateral keel extent

$ML_K$ (FIG. **4**B) of larger sizes of tibial baseplate **12**. Advantageously, the increased medial/lateral extent $ML_{KA}$ defined by fins **17**A of keel **16**A present high resistance to rotation of tibial baseplate **12** in vivo, and enhance the overall strength of baseplate **12**.

Yet another unique feature of keel **16**A in small stature sizes of tibial baseplate **12** is its overall longitudinal extent $PD_{KA}$, which extends in a generally proximal/distal direction as shown in FIG. **10**. Longitudinal extent $PD_{KA}$ of the small-stature sizes of tibial baseplate **12** is substantially reduced with respect to longitudinal extent $PD_K$ (FIG. **4**B) of keel **16** in the larger sizes of tibial baseplate **12**, and with respect to small baseplate sizes in other, alternative tibial baseplate designs. In an exemplary embodiment, longitudinal extend $PD_{KA}$ of small stature tibial keel **16**A may be about 27 mm, while longitudinal extent $PD_K$ of larger tibial keel **16** may range from about 39 mm to about 48 mm.

Advantageously, the above-described special geometries and features of small stature tibial keel **16**A prevent impingement of the conical outer surface of the body of keel **16**A and/or fins **17**A upon cortical bone when implanted upon the tibia of a small stature patient for which the small stature sizes of tibial baseplate **12** are intended. More particularly, Applicant has found that cortical bone impingement, is most likely to occur (if at all) at or near the distal tip of a tibial keel in small stature patients. To minimize the probability of such impingement, small stature tibial keel **16**A of tibial baseplate **12** includes the above-described unique features while also retaining a large fixation area for attachment to the surrounding tissues, and maintaining a high minimum material thickness to ensure appropriate strength throughout the material of tibial baseplate **12**. For example, the high value of keel fin angle $\gamma_A$ (described in detail above) increases the surface area for fixation of tibial baseplate **12** to the surrounding bone, while the tapered outer surface of keel **16**A ensures that a nominal minimum wall thickness of 1.5 mm is maintained throughout the material of tibial baseplate **12** while presenting a relatively small radius at the distal tip of keel **16**A.

The probability of cortical bone impingement by keel **16**A is also minimized by medially biasing the position of keel **16**A with respect to the tibial baseplate periphery (i.e., peripheries $\mathbf{200}_1$ and $\mathbf{200}_2$). More particularly, small-stature sizes of tibial baseplate **12** have keel **16**A offset approximately 1 mm from a centered position on distal surface **35** of tibial plateau **18**, thereby enhancing the probability of proper alignment with the anatomic intramedullary canal and concomitantly minimizing the probably of cortical bone impingement. Medialization of keel **16**A (and of keel **16** for larger sizes of baseplate **12**) is described in detail in U.S. Provisional Patent Application Ser. No. 61/562,133, filed Nov. 21, 2011 and entitled TIBIAL BASEPLATE WITH ASYMMETRIC PLACEMENT OF FIXATION STRUCTURES, and in U.S. Provisional Patent Application Ser. No. 61/592,571, entitled TIBIAL BASEPLATE WITH ASYMMETRIC PLACEMENT OF FIXATION STRUCTURES and filed Jan. 30, 2012, and in U.S. Provisional Patent Application Ser. No. 61/594,030, entitled TIBIAL BASEPLATE WITH ASYMMETRIC PLACEMENT OF FIXATION STRUCTURES and filed Feb. 2, 2012, and in U.S. Provisional Patent Application Ser. No. 61/621,369, entitled TIBIAL BASEPLATE WITH ASYMMETRIC PLACEMENT OF FIXATION STRUCTURES and filed on Apr. 6, 2012, and in U.S. patent application Ser. No. 13/593,339, entitled TIBIAL BASEPLATE WITH ASYMMETRIC PLACEMENT OF FIXATION STRUCTURES and filed on Aug. 23, 2012, the entire disclosures of which are hereby expressly incorporated herein by reference.

Small stature tibial keel **16**A also includes some features common to tibial keel **16** of larger sizes of tibial baseplate **12**. For example, small stature tibial keel **16**A includes a tapered bore **19** (FIG. **9**) extending proximally into keel **16**A from the distal tip thereof, which is designed to mate with a corresponding locking-taper surface **21** of tibial stem extension **23**. The locking taper formed between the inner surface of bore **19** and surface **21** may define an angle of approximately 5° with respect to the shared longitudinal axis of keel **16**A and stem extension **23** upon assembly. Further, a secondary locking mechanism may be provided in the form of set screw aperture **27**A (FIG. **11**) formed in a posterior portion of the outer wall of keel **16**A. Set screw aperture **27**A is positioned to align with annular groove **27**B formed in stem extension **23** when tapered surface **21** is fully, lockingly seated with the correspondingly tapered inner surface bore **19**. A set screw may then be threaded into aperture **27**A to engage annular groove **27**B, thereby offering secondary prevention of relative axial movement between stem extension **23** and tibial baseplate **12**.

4. PCL Cutout Aligned with Home Axis and Associated Technique

In the illustrated embodiment, tibial plateau **18** includes PCL cutout **28** disposed between compartments **20**, **22**, as described above. PCL cutout leaves PCL attachment point $C_P$ accessible, thereby allowing the PCL to pass therethrough during and after implantation of tibial baseplate **12**. Tibial bearing component **14** (FIG. **5**) may similarly include cutout **30**.

Thus, the illustrated embodiment of tibial prosthesis **10** is adapted for a cruciate retaining (CR) surgical procedure, in which the posterior cruciate ligament is not resected during implantation of tibial prosthesis **10**. Further, as noted above, home axis $A_H$ includes reference to PCL attachment point $C_P$ when tibial baseplate **12** is mounted upon tibia T. In order to facilitate alignment of home axis $A_H$ with respect to tibial baseplate **12** and tibia T, alignment indicia **70**A, **70**P (FIGS. **4**A and **4**B) may be marked on proximal surface **34** and/or peripheral wall **25**. When tibial baseplate **12** is implanted (as described below), anterior alignment indicia **70**A (FIGS. **4**A and **4**B) is aligned with anterior point $C_A$ at the "medial third" of the anterior tibial tubercle T, and posterior alignment indicia **70**P is aligned with the natural PCL attachment point $C_P$ of tibia T.

However, it is contemplated that a prosthesis in accordance with the present disclosure may be made for a design in which the posterior cruciate ligament is resected during surgery, such as "posterior stabilized" (PS) or "ultra congruent" (UC) designs. The PS and UC designs may exclude PCL cutout **30** in bearing component **14**, thereby obviating the need for PCL cutout **28** in tibial baseplate **12**. Continuous material may instead occupy cutout **28** (as schematically shown in FIG. **3**D). Moreover, it is contemplated that PCL cutouts **28**, **30** may have any shape and/or size within the scope of the present disclosure. For example, PCL cutouts **28**, **30** may be asymmetrical with respect to an anteroposterior axis. For purposes of the present disclosure "bisecting" an asymmetric PCL cutout with an anteroposterior axis refers to dividing such cutout into two equal areas for a given anteroposterior section of the anteroposterior axis

5. Tibial Bearing Component and Deep Flexion Enablement

Turning again to FIG. **1**A, tibial bearing component **14** includes lateral portion **39**, medial portion **41**, inferior surface **36** adapted to couple to tibial baseplate **12**, and superior surface **38** adapted to articulate with condyles of a femoral component (such as femoral component **60** shown in FIG. **8**

and described in detail below). Superior surface **38** includes lateral articular surface **40** in lateral portion **39** and medial articular surface **42** in medial portion **41**, with eminence **44** (FIG. **5**) disposed between articular surfaces **40**. **42**. Referring to FIG. **5**, eminence **44** generally corresponds in shape and size with a natural tibial eminence of tibia T prior to resection.

Referring now to FIG. **1**A, tibial plateau **18** of tibial baseplate **12** further includes a distal or bone contacting surface **35** and an opposing proximal or superior surface **34**, with superior surface **34** having raised perimeter **24** and locking mechanism **26** formed between lateral and medial compartments **20**, **22**. Raised perimeter **24** and locking mechanism **26** cooperate to retain tibial bearing component **14** upon tibial baseplate **12**, as described in detail below.

Inferior surface **36** of tibial bearing component **14** includes recess **46** at the periphery thereof and a tibial bearing locking mechanism (not shown) disposed between lateral and medial articular surfaces **40**, **42**. Recess **46** is sized and positioned to correspond with raised perimeter **24** of tibial plateau **18**, and the tibial bearing locking mechanism cooperates with locking mechanism **26** of tibial plateau **18** to fix tibial bearing component **14** to tibial baseplate **12** in a desired position and orientation as described in detail below. However, it is contemplated that tibial bearing component **14** may be affixed to baseplate **12** by any suitable mechanism or method within the scope of the present disclosure, such as by adhesive, dovetail tongue/groove arrangements, snap-action mechanisms, and the like.

Exemplary baseplate and tibial bearing locking mechanisms are described in U.S. Patent Application Publication No. 2012/0035737, filed Jul. 22, 2011 and entitled TIBIAL PROSTHESIS, and in U.S. Patent Application Publication No. 2012/0035735, filed Jul. 22, 2011 and entitled TIBIAL PROSTHESIS, the entire disclosures of which are hereby expressly incorporated by reference herein.

As best seen in FIGS. **1**B, **5** and **8**, the outer periphery of tibial bearing component **14** generally corresponds with the outer periphery of tibial plateau **18**, except for the posteromedial extent of plateau **18** as compared with tibial bearing component **14**. The anterolateral "corner" of tibial bearing component **14** defines radius $R_3$ (FIG. **5**) having a generally common center with radius R**2**L of baseplate **12** in a transverse plane, i.e., radii R**2**L and $R_3$ are substantially coincident in a plan view. Similarly, the anteromedial "corner" of tibial bearing component **14** defines radius $R_4$ having a generally common center with radius R**1**R of baseplate **12** in a transverse plane, i.e., radii R**1**R and $R_4$ are substantially coincident in a plan view.

$R_3$ defines a slightly smaller radial length as compared to R**2**L, and $R_4$ defines a slightly smaller radial length as compared to RIR, such that the anterior portion of perimeter wall **54** of tibial bearing component **14** is set back from the anterior portion of peripheral wall **25** (i.e., from anterior edge **202** and adjacent arcs, as described above) of tibial baseplate **12**. As with the above-described comparison between radii R**2**L and R**1**R, anteromedial radius $R_4$ is substantially larger than anterolateral radius $R_3$.

Given that medial portion **41** of tibial bearing component **14** has a lesser anteroposterior extent compared to medial compartment **22** of tibial plateau **18**, medial portion **41** must be biased anteriorly in order for the anterior-medial "corners" of tibial bearing component **14** and tibial plateau **18** to coincide as shown in FIG. **5**. In view of this anterior bias, it may be said that tibial bearing component **14** is asymmetrically oriented upon tibial plateau **18**. More particularly, although lateral articular surface **40** is generally centered with respect to lateral compartment **20** of tibial plateau **18**, medial articular surface **42** is anteriorly biased with respect to medial compartment **22** of tibial plateau **18** in order to leave chamfer **32** exposed at the posterior-lateral corner. This asymmetric mounting of tibial bearing component **14** upon tibial plateau **18** ensures a desired articular interaction between tibial prosthesis **10** and femoral component **60**, as described in detail below.

Tibial plateau **18** of tibial baseplate **12** deviates from the periphery of tibial bearing component **14** in the posteromedial portion of each component, leaving medial portion **41** incongruent with medial compartment **22** of tibial baseplate **12**. More particularly, tibial plateau **18** extends posteromedially to substantially cover the proximal resected surface of tibia T, as shown in FIG. **5** and described in above, while tibial bearing component **14** does not extend posteromedially beyond the superior terminus of chamfer **32** (i.e., tibial bearing component **14** does not "overhang" chamfer **32**). In addition, tibial bearing component **14** includes chamfer **50** formed in peripheral wall **54**, with chamfer **50** having a profile and geometrical arrangement corresponding with chamfer **32** of tibial plateau **18**. More particularly, when tibial bearing component **14** is assembled to tibial baseplate **12** as shown in FIGS. **1**B and **8**, the anterior orientation or "bias" of the medial portion of tibial bearing component **14** (as described above) aligns chamfers **32**, **50**, which in turn cooperate to create a substantially continuous chamfer extending from tibia T to medial articular surface **42**. Referring to FIG. **8**, chamfers **32**, **50** further cooperate to define void **52** formed between femur F and tibial plateau **18** when tibial prosthesis **10** is in a deep flexion orientation. In the illustrated embodiment of FIG. **8**, the deep flexion orientation is defined by angle β between anatomic tibia axis $A_T$ and anatomic femoral axis $A_F$ of up to about 25 degrees to about 40 degrees, for example (i.e., about 140 degrees to 155 degrees of flexion or more).

Advantageously, void **52** cooperates with the "pulled back" or incongruent posterior medial edge **206** and posterior medial corner **224**, as compared to a typical tibial periphery (described above), to allow the deep flexion orientation to be achieved without impingement of femoral component **60** and/or femur F upon tibial plateau **18** and/or tibial bearing component **14**. Soft tissues in the region of void **52** are therefore also accommodated with little or no impingement on the surrounding components.

In addition, the relatively large size of tibial plateau **18** (covering a large proportion of the resected proximal surface of tibia T) also allows tibial bearing component **14** to be relatively large, so that tibial bearing component **14** provides sufficient non-articular surface area at chamfers **32**, **50** and around the periphery of lateral and medial articular surfaces **40**, **42** to allow relatively large-radius, rounded transitions between articular surfaces **40**, **42** and peripheral wall **54** of tibial bearing component **14**. These gradual, large-radius transitions prevent undue friction between tibial prosthesis **10** and any surrounding soft tissues which may remain in place after implantation of the prosthesis, such as the iliotibial (IT) band.

In certain ranges of prosthesis articulation, for example, the human iliotibial (IT) band may touch the anterolateral "corner", i.e., the portion of tibial bearing component **14** having radius $R_3$. Because the anterolateral extent of tibial bearing component **14** follows the anterolateral extent of tibial plateau **18** (as described above), the transition between lateral articular surface **40** and peripheral wall **54** at the point of contact between an IT band and tibial bearing component **14** can have a relatively large convex portion while still leaving sufficient concave space for articular surface **40**. This

large convex portion results in a large contact area if the IT band does contact tibial bearing component **14**, which in turn results in relatively low pressures on the IT band. Further, the anterolateral "pull back" or incongruence between the anterior-lateral corner arc **210** of periphery **200** and a typical tibial periphery, described in detail above, allows the corresponding anterior-lateral corner of bearing component **14** to maintain separation from the IT band through a wide range of flexion, and low contact pressures where contact does occur.

However, to any such contact between the IT band and tibial bearing component **14** may be avoided or minimized by designing periphery **200** such that anterior-lateral corner arc **210** and/or lateral edge arc **212** is brought away from the expected periphery of a typical tibia T (as calculated from anatomical data, described above). This extra spacing designed into periphery **200** provides extra clearance for the iliotibial band. In addition, this extra clearance assures that the substantial proportion of prospective patients lacking Gerdy's tubercle, which is an eminence located at the anterior-lateral portion of tibia T, will not experience any "overhang" of tibial plateau **18** beyond the anatomic periphery of resected tibia T.

Thus, generally speaking, tibial prosthesis **10** can be considered "soft tissue friendly" because the edges of tibial bearing component **14** and tibial plateau **18**, including chamfers **32**, **50**, are smooth and rounded, so that any soft tissue coming into contact with these edges will be less likely to chafe or abrade.

Advantageously, the relatively large inferior/distal surface area of tibial plateau **18** facilitates a large amount of bone ingrowth where bone ingrowth material is provided in tibial baseplate **12**. For example, baseplate **12** may also be constructed of, or may be coated with, a highly porous biomaterial. A highly porous biomaterial is useful as a bone substitute and as cell and tissue receptive material. A highly porous biomaterial may have a porosity as low as 55%, 65%, or 75% or as high as 80%, 85%, or 90%. An example of such a material is produced using Trabecular Metal™ Technology generally available from Zimmer, Inc., of Warsaw, Ind. Trabecular Metal™ is a trademark of Zimmer, Inc. Such a material may be formed from a reticulated vitreous carbon foam substrate which is infiltrated and coated with a biocompatible metal, such as tantalum, by a chemical vapor deposition ("CVD") process in the manner disclosed in detail in U.S. Pat. No. 5,282,861 to Kaplan, the entire disclosure of which is hereby expressly incorporated herein by reference. In addition to tantalum, other metals such as niobium, or alloys of tantalum and niobium with one another or with other metals may also be used.

Generally, the porous tantalum structure includes a large plurality of ligaments defining open spaces therebetween, with each ligament generally including a carbon core covered by a thin film of metal such as tantalum, for example. The open spaces between the ligaments form a matrix of continuous channels having no dead ends, such that growth of cancellous bone through the porous tantalum structure is uninhibited. The porous tantalum may include up to 75%, 85%, or more void space therein. Thus, porous tantalum is a lightweight, strong porous structure which is substantially uniform and consistent in composition, and closely resembles the structure of natural cancellous bone, thereby providing a matrix into which cancellous bone may grow to provide fixation of implant [#] to the patient's bone.

The porous tantalum structure may be made in a variety of densities in order to selectively tailor the structure for particular applications. In particular, as discussed in the above-incorporated U.S. Pat. No. 5,282,861, the porous tantalum may be fabricated to virtually any desired porosity and pore size, and can thus be matched with the surrounding natural bone in order to provide an improved matrix for bone ingrowth and mineralization.

6. Trial Tibial Components

Tibial prosthesis **10** may be provided in a variety of sizes and configurations to accommodate different bone sizes and geometries. The choice of one particular size may be planned preoperatively such as through preoperative imaging and other planning procedures. Alternatively, an implant size may be chosen, or a previous size choice modified, intraoperatively. To facilitate proper intraoperative selection of a particular size for tibial prosthesis **10** from among the family of sizes shown in FIG. **2**A, and to promote proper orientation of the chosen prosthesis **10**, tibial prosthesis **10** may be part of a kit including one or more template or "sizing" components.

Referring now to FIGS. **6** and **7**, trial prosthesis **100** may be temporarily coupled to tibia T for intraoperative sizing evaluation of tibial prosthesis **10** and initial steps in the implantation of tibial prosthesis **10**. Trial prosthesis **100** is one of a set of trial prostheses provided as a kit, with each trial prosthesis having a different size and geometrical configuration. Each trial prosthesis in the set of trial prostheses corresponds to a permanent prosthesis **10**, such as sizes **1**/A-**9**/J of tibial baseplate **12** as described above.

For example, as shown in FIG. **6**, trial prosthesis **100** defines superior surface **112** generally corresponding in size and shape to proximal surface **34** of tibial plateau **18**, and including lateral portion **102** and medial portion **104**. Superior surface **112** is asymmetrical about home axis $A_H$, with lateral portion **102** having a generally shorter overall anteroposterior extent as compared to medial portion **104** (which includes void indicator **106**, discussed below). In addition, the anterolateral "corner" of lateral portion **102** defines radius R**2**L, which is identical to radius R**2**L of tibial plateau **18**, while the anteromedial "corner" of medial portion **104** defines radius RIR, which is identical to radius R**1**R of tibial plateau **18** and greater than radius R**2**L.

Moreover, perimeter wall **114** of trial prosthesis **100** is substantially identical to peripheral wall **25** of tibial plateau **18**, and therefore defines periphery **200** with the same features and shapes of perimeter **200** described above with respect to tibial plateau **18**. Thus, trial prosthesis **100** is asymmetrical about home axis $A_H$ in a similar manner to tibial plateau **18** of tibial baseplate **12**, with the nature of this asymmetry changing across the various other sizes of tibial prosthesis provided in the kit including trial prosthesis **100**.

In an alternative embodiment, a trial prosthesis may be provided which extends completely to the posterior-medial edge of the natural tibial resection periphery. Thus, such a trial would substantially completely cover the resected tibial surface, thereby aiding in determination of a proper rotational orientation of the trial (and, therefore, of the final tibial baseplate **12**). In this alternative embodiment, the trial prosthesis lacks the posterior-medial "pull back" of tibial plateau **18**, described above.

Trial prosthesis **100** includes void indicator **106** disposed at the posterior portion of medial portion **104**, consuming a given posteromedial area of superior surface **34** and peripheral wall **25**. Void indicator **106** indicates where void **52** (discussed above) will be located with respect to tibia T after implantation of tibial prosthesis **10**. Void indicator **106** facilitates proper rotational and spatial orientation of trial prosthesis **100** on the resected proximal surface of tibia T by allowing a surgeon to visually match tibial bearing component **14** with trial prosthesis **100**, as described in detail below. In the illustrated embodiment, void indicator **106** is an area of visual

and/or tactile contrast with the remainder of tibial plateau **18**. This contrast may include, for example, a contrasting color, texture, surface finish, or the like, or may be formed by a geometric discrepancy such as a step or lip, for example.

Referring specifically to FIG. **6**, trial prosthesis **100** further includes a plurality of peg hole locators **108** corresponding to the proper location for peg holes in tibia T to receive pegs (not shown) extending inferiorly from tibial plateau **18** of tibial baseplate **12**. Advantageously, peg hole locators **108** allow a surgeon to demarcate the proper center for peg holes in tibia T once the proper size and orientation for trial prosthesis **100** has been found, as discussed in detail below. Alternatively, peg hole locators **108** may be used as drill guides to drill appropriately positioned peg holes while trial prosthesis is still positioned on tibia T.

7. Tibial Prosthesis Implantation

In use, a surgeon first performs a resection of tibia T using conventional procedures and tools, as are well-known in the art. In an exemplary embodiment, a surgeon will resect the proximal tibia to leave a planar surface prepared for receipt of a tibial baseplate. This planar surface may define a tibial slope, which is chosen by the surgeon. For example, the surgeon may wish to perform a resection resulting in positive tibial slope in which the resected tibial surface slopes proximally from posterior to anterior (i.e., the resected surface runs "uphill" from posterior to anterior). Alternatively, the surgeon may instead opt for negative tibial slope in which the resected tibial surface slopes distally from posterior to anterior (i.e., the resected surface runs "downhill" from posterior to anterior). Varus or valgus slopes may also be employed, in which the resected surface slopes proximally or distally from medial to lateral. The choice of a tibial and/or varus/valgus slope, and the amount or angle of such slopes, may depend upon a variety of factors including correction of deformities, mimicry of the native/preoperative tibial slope, and the like.

In an exemplary embodiment, keel **16** (FIG. **4**B) defines a 5-degree, anteriorly-extending angle with respect to bone-contacting surface **35** of tibial plateau **18**. Tibial baseplate **12** is appropriate for use with a positive tibial slope of as little as zero degrees and as much as 9 degrees, and with a varus or valgus slope of up to 3 degrees. However, it is contemplated that a tibial baseplate made in accordance with the present disclosure may be used with any combination of tibial and/or varus/valgus slopes, such as by changing the angular configuration of the keel with respect to the bone-contacting surface.

With a properly resected proximal tibial surface, the surgeon selects trial prosthesis **100** from a kit of trial prostheses, with each prosthesis in the kit having a different size and geometrical configuration (as discussed above). Trial prosthesis **100** is overlaid on the resected surface of tibia T. If trial prosthesis **100** is appropriately sized, a small buffer zone **110** of exposed bone of resected tibia T will be visible around the periphery of trial prosthesis **100**. Buffer **110** is large enough to allow a surgeon to rotate and/or reposition trial prosthesis **100** within a small range, thereby offering the surgeon some flexibility in the final positioning and kinematic profile of tibial prosthesis **10**. However, buffer **110** is small enough to prevent trial prosthesis **100** from being rotated or moved to an improper location or orientation, or from being implanted in such as way as to produce excessive overhang of the edge of trial prosthesis **100** past the periphery of the resected tibial surface. In one exemplary embodiment, for example, trial prosthesis may be rotated from a centered orientation by up to +/−5 degrees (i.e., in either direction), though it is contemplated that such rotation may be as much as +/−10 degrees or +/−15 degrees.

To aid in rotational orientation, trial prosthesis may include anterior and posterior alignment indicia **70**A, **70**P, which are the same marks in the same location as indicia **70**A, **70**P provided on tibial plateau **18** as described above. The surgeon can align indicia **70**A with anterior point $C_A$ and indicia **70**P with PCL attachment point Cp, in similar fashion as described above, to ensure the anatomical and component home axes $A_H$ are properly aligned. Alternatively, a surgeon may use indicia **70**A, **70**P to indicate a desired deviance from alignment with home axis $A_H$. As noted above, deviation of up to 5 degrees is envisioned with the exemplary embodiments described herein. A surgeon may choose to orient indicia **70**A, **70**P to another tibial landmark, such as the middle of the patella or the medial end of tibial tubercle B.

Thus, the large coverage of trial prosthesis **100** (and, concomitantly, of tibial plateau **18**) ensures that tibial baseplate **12** will be properly positioned and oriented on tibia T upon implantation, thereby ensuring proper kinematic interaction between tibial prosthesis **10** and femoral component **60**. If buffer zone **110** is either nonexistent or too large, another trial prosthesis **100** is selected from the kit and compared in a similar fashion. This process is repeated iteratively until the surgeon has a proper fit, such as the fit illustrated in FIGS. **6** and **7** between trial prosthesis **100** and tibia T.

With the proper size for trial prosthesis **100** selected and its orientation on tibia T settled, trial prosthesis **100** is secured to tibia T, such as by pins, screws, temporary adhesive, or any other conventional attachment methods. Once trial prosthesis is so secured, other trial components, such as trial femoral components and trial tibial bearing components (not shown) may be positioned and used to articulate the leg through a range of motion to ensure a desired kinematic profile. During such articulation, void indicator **106** indicates to the surgeon that any impingement of femoral component **60** and/or femur F upon trial prosthesis **100** at void indicator **106** will not occur when tibial prosthesis **10** is implanted. Once the surgeon is satisfied with the location, orientation and kinematic profile of trial prosthesis **100**, peg hole locators **108** may be used to demarcate the appropriate location of peg holes in tibia T for tibial baseplate **12**. Such peg holes may be drilled in tibia T with trial prosthesis **100** attached, or trial prosthesis **100** may be removed prior to drilling the holes.

With tibia T prepared for receipt of tibial prosthesis **10**, tibial baseplate **12** may be provided by the surgeon (such as from a kit or surgical inventory), and is implanted on tibia T, with pegs fitting into holes previously identified and demarcated using peg hole locators **108** of trial prosthesis **100**. Tibial baseplate **12** is selected from the family of tibial baseplates illustrated in FIG. **2**A to correspond with the trial component **100** chosen, which ensures that tibial plateau **18** will cover a large proportion of the resected proximal surface of tibia T, as trial prosthesis **100** did prior to removal. Tibial baseplate is affixed to tibia T by any suitable method, such as by keel **16** (FIG. **4**B), adhesive, bone-ingrowth material, and the like.

With tibial baseplate **12** installed, tibial bearing component **14** may be coupled with tibial baseplate **12** to complete tibial prosthesis **10**. However, once attached, tibial bearing component **14** does not fully cover tibial plateau **18** of tibial baseplate **12**. Rather, tibial bearing component **14** leaves a posteromedial portion of tibial baseplate **12** uncovered to create void **52** (as shown in FIG. **8** and discussed above). Thus, a surgeon may wish to verify that this anterior-biased, "asymmetrical" orientation of medial articular surface **42** is proper prior to permanent affixation of tibial bearing component **14** to tibial baseplate **12**.

To accomplish such verification, tibial bearing component **14** is placed side-by-side with trial prosthesis **100**, with inferior surface **36** of tibial bearing component **14** in contact with superior surface **112** of trial prosthesis **100**. Tibial bearing component **14** will substantially cover superior surface **112**, but will not cover void indicator **106**. Put another way, peripheral wall **54** of tibial bearing component **14** will trace perimeter wall **114** of tibial trial prosthesis **100**, excluding the posteromedial area defined by void indicator **106**. If inferior surface **36** of tibial bearing component **14** is a match with superior surface **112** of trial prosthesis **100** except for void indicator **106** (which is left uncovered by tibial bearing component **14**), then tibial bearing component **14** is the proper size component and may be confidently installed upon tibial plateau **18** of tibial baseplate **12**.

Tibial baseplate **12** may then be implanted upon the proximal surface of tibia T in accordance with accepted surgical procedures. Exemplary surgical procedures and associated surgical instruments are disclosed in "Zimmer LPS-Flex Fixed Bearing Knee, Surgical Technique," "NEXGEN COMPLETE KNEE SOLUTION, Surgical Technique for the CR-Flex Fixed Bearing Knee" and "Zimmer NexGen Complete Knee Solution Extramedullary/Intramedullary Tibial Resector, Surgical Technique" (collectively, the "Zimmer Surgical Techniques"), copies of which are submitted on even date herewith in an information disclosure statement, the entire disclosures of which are hereby expressly incorporated by reference herein.

When the surgeon is satisfied that tibial bearing component **14** is properly matched and fitted to the installed tibial baseplate **12**, bearing component **14** is secured using locking mechanism **26** and the corresponding tibial bearing locking mechanism an appropriate instrumentation (not shown). Proper location and rotational orientation of tibial bearing component **14** upon tibial plateau **18** is ensured by raised perimeter **24** cooperating with recess **46**, and locking mechanism **26** cooperating with the corresponding tibial bearing locking mechanism (not shown). Such proper orientation results in medial articular surface **42** being generally anteriorly disposed with respect to medial compartment **22** of tibial plateau **18**.

Femoral component **60** may be affixed to a distal end of femur F, if appropriate, using any conventional methods and/or components. Exemplary surgical procedures and instruments for such affixation are disclosed in the Zimmer Surgical Techniques, incorporated by reference above. Femur F and tibia T may then be articulated with respect to one another to ensure that neither femur F nor femoral component **60** impinges upon tibial baseplate **12** and/or tibial bearing component **14** in deep flexion, such as at a flexion angle $\beta$ of 155° as shown in FIG. **8**. When the surgeon is satisfied with the location, orientation and kinematic profile of tibial prosthesis **10**, the knee replacement surgery is completed in accordance with conventional procedures.

While this invention has been described as having an exemplary design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

What is claimed is:

**1**. A small-stature tibial baseplate, comprising:

a tibial plateau comprising:

a distal surface sized and shaped to substantially cover a proximal resected surface of a tibia;

a proximal surface opposite said distal surface, said proximal surface having a lateral compartment and a medial compartment opposite said lateral compartment, the lateral compartment is asymmetric with respect to the medial compartment about a component anteroposterior axis to define a component asymmetry; and

a peripheral wall extending between said distal surface and said proximal surface, wherein a total surface area bounded by said peripheral wall of said tibial plateau is between about 1390 $mm^2$ and about 1580 $mm^2$;

a tibial keel extending distally from said distal surface of said tibial plateau to define a longitudinal tibial keel axis; and

a medial fin and a lateral fin spanning a junction between said tibial keel and said distal surface, each of said medial fin and said lateral fin comprising a fin edge having a planar portion defining an angle of about 45 degrees with respect to said longitudinal tibial keel axis, said medial fin and said lateral fin cooperating to define a medial/lateral fin extent of about 40 mm.

**2**. The small-stature tibial baseplate of claim **1**, wherein said tibial keel defines a longitudinal extent equal to about 27 mm.

**3**. The small-stature tibial baseplate of claim **1**, wherein said at least one fin extends along less than an entire longitudinal extent of said tibial keel.

**4**. The small-stature tibial baseplate of claim **3**, wherein said at least one fin extends along about 74% of said entire longitudinal extent of said tibial keel.

**5**. The small-stature tibial baseplate of claim **1**, wherein said tibial keel s formed as a monolithic, one-piece keel.

**6**. The small-stature tibial baseplate of claim **5**, wherein said tibial keel monolithically formed with said tibial plateau.

**7**. The small-stature tibia baseplate of claim **1**, wherein said tibia keel comprises:

a first diameter at said junction between said distal surface and said tibial keel; and

a second diameter at a distal tip of said tibial keel, said first diameter larger than said second diameter.

**8**. The small-stature tibial baseplate of claim **7**, wherein said first diameter is about 17.1 mm and said second diameter is about 13.4 mm.

**9**. The small-stature tibial baseplate of claim **7**, wherein said tibial keel comprises a tapered outer profile extending between said first diameter and said second diameter.

**10**. The small-stature tibial baseplate of claim **9**, wherein said tapered outer profile of said tibial keel defines a taper angle of about 9 degrees.

**11**. The small-stature tibial baseplate of claim **1**, wherein said tibial keel defines a longitudinal extent, said tibial keel having a minimum diameter along said longitudinal extent of at least 13 mm.

**12**. The small-stature tibial baseplate of claim **1**, wherein said tibial keel comprises a tapered bore extending proximally into said tibial keel from a distal tip of said tibial keel, said tapered bore sized to receive a correspondingly tapered proximal end of a tibial stem extension, such that said tapered proximal end of said tibial stem extension forms a locking taper connection with said tapered bore.

13. The small-stature tibial baseplate of claim 12, wherein:

said tibial keel comprises a set screw aperture extending from an outer surface of said tibial keel to an inner surface defined by said tapered bore; and

said tapered proximal end of said tibial stem extension comprises an annular groove positioned to align with said set screw aperture when said locking taper connection is formed between said tibial stem extension and said tapered bore.

14. The small-stature tibial baseplate of claim 13, in combination with a set screw receivable within said set screw aperture, said set screw extending into said annular groove to form a secondary locking mechanism preventing relative axial movement between said tibial stem extension and said tibial keel when said locking taper connection is formed between said tibial stem extension and said tapered bore.

15. The small-stature tibial baseplate of claim 1, wherein said tibial plateau defines an overall medial/lateral extent of between about 57 mm and about 61 mm.

16. A small-stature tibial baseplate, comprising:

a tibial plateau comprising:

a distal surface sized and shaped to substantially cover a proximal resected surface of a tibia;

a proximal surface opposite said distal surface, said proximal surface having a lateral compartment and a medial compartment opposite said lateral compartment, the lateral compartment is as asymmetric with respect to the medial compartment about a component anteroposterior axis to define a component asymmetry; and

a peripheral wall extending between said distal surface and said proximal surface, wherein a total surface area bounded by said peripheral wall of said tibial plateau is between about 1390 $mm^2$ and about 1580 $mm^2$;

a tibial keel extending distally from a junction with said distal surface to an opposing distal tip, said tibial keel positioned so as to substantially coincide with an intramedullary canal of the tibia when said distal surface is placed upon the tibia, said tibial keel comprising a first diameter at said junction between said distal surface and said tibial keel and a second diameter at said distal tip of said tibial keel, each of said first diameter and said second diameter equal to or greater than 13 mm, the first diameter greater than the second diameter; and

a medial fin and a lateral fin each spanning a portion of said junction between said tibial keel and said tibial plateau, wherein each of said medial fin and said lateral fin comprising a fin edge having a planar portion defining an angle of about 45 degrees with respect to a longitudinal tibial keel axis, said medial fin mating with said distal surface at said medial compartment, said lateral fin mating with said distal surface at said lateral compartment, wherein said medial and lateral fins cooperate to define a medial/lateral fin extent of about 40 mm.

17. The small-stature tibial baseplate of claim 16 wherein said tibial keel comprises a tapered outer profile extending between said first diameter and said second diameter.

18. The small-stature tibial baseplate of claim 17, wherein said tapered outer profile of said tibial keel defines a taper angle of 9 degrees.

19. The small-stature tibial baseplate of claim 16 wherein said tibial plateau defines an overall medial/lateral extent of between about 57 mm and about 61 mm.

20. The small-stature tibial baseplate of claim 19, wherein said tibial plateau defines an overall anterior/posterior extent substantially perpendicular to said overall medial/lateral extent, said overall anterior/posterior extent between about 40 mm and about 43 mm.

21. The small-stature tibial baseplate of claim 20, wherein said medial and lateral fins extend along less than an entire longitudinal extent of said tibial keel.

22. The small-stature tibial baseplate of claim 21, wherein said medial and lateral fins extend along about 74% of said entire longitudinal extent of said tibial keel.

23. The small-stature tibial baseplate of claim 16, wherein said tibial keel is monolithically formed with said tibial plateau.

24. The small-stature tibial baseplate of claim 16, wherein said tibial keel is separately attachable to said tibial plateau.

25. The small-stature tibial baseplate of claim 16, wherein said tibial keel comprises a tapered bore extending proximally into said tibial keel from said distal tip of said tibial keel, said tapered bore sized to receive a corresponding tapered proximal end of a stem extension to form a locking taper connection.

26. The small-stature tibial baseplate of claim 25, wherein said tibial keel comprises a set screw aperture formed in a posterior portion of an outer wall of said tibial keel, said set screw aperture positioned to align with an annular groove formed in said tapered proximal end of said stem extension when said tapered proximal end is fully, lockingly seated within said tapered bore.

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